PROGRAM MANAGER
RMA CONTAMINATION CLEANUP

U.S. ARMY
MATERIEL COMMAND

— COMMITTED TO PROTECTION OF THE ENVIRONMENT —

Final Technical Plan
July 1988

Contract Number DAAK11-84-D-0016
Task Number 39

Environmental Science And Engineering, Inc.
Harding Lawson Associates

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LITIGATION TECHNICAL SUPPORT AND SERVICES

Rocky Mountain Arsenal

Offpost Remedial Investigation/Feasibility Study

Final Technical Plan
July 1988

Contract Number DAAK11-84-D-0016
Task Number 39

PREPARED BY

ENVIRONMENTAL SCIENCE & ENGINEERING, INC.

Harding Lawson Associates

PREPARED FOR:

U.S. PROGRAM MANAGER'S OFFICE FOR
ROCKY MOUNTAIN ARSENAL

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THE OBJECTIVE OF THIS TASK IS TO CONDUCT A REMEDIAL INVESTIGATION AND FEASIBILITY STUDY OFF-POST OF RMA. THIS RI/FS WILL:

1. EVALUATE THE EXTENT OF CONTAMINATION TO THE NORTH AND NORTHWEST OF THE ARSENAL
2. ESTIMATE THE RISK TO THE ENVIRONMENT AND PUBLIC HEALTH
3. IDENTIFY APPROPRIATE REMEDIAL RESPONSES.

SECTIONS OF THE REPORT DISCUSS THE FOLLOWING:

1. GEOTECHNICAL AND CHEMICAL ANALYSES
2. GROUND WATER SAMPLING
3. SAFETY PLAN FOR FIELD ACTIVITIES
4. DATA MANAGEMENT AND EVALUATION OF DATA
5. EA METHODOLOGY WHICH WILL BE REQUIRED IN ORDER TO DETERMINE THE MAGNITUDE AND PROBABILITY OF ACTUAL OR POTENTIAL HARM TO THE PUBLIC OR THE ENVIRONMENT

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EXECUTIVE SUMMARY

The objective of this task is to conduct a Remedial Investigation and Feasibility Study (RI/FS) offpost of Rocky Mountain Arsenal (RMA). This offpost RI/FS will evaluate the extent of contamination to the north and northwest of the RMA; estimate the risk to the environment and public health; and, if appropriate, identify, screen, and select a cost-effective remedial response. The remedial response will consist of single or multiple remedial technologies that mitigate or eliminate environmental damage and public health risk.

Although the object of this task is to explore the need for long-term remedial action for the offpost study area, interim response actions may also prove to be appropriate. Such interim action will be addressed in separate tasks, if necessary, and will be consistent with the final remedy selected as a result of this offpost RI/FS.

The remedial action alternatives analysis to be performed under this task will be conducted according to current federal regulations and associated guidance documents. At present, federal programs for hazardous waste site remediation are in transition due to passage of new legislation. This situation may persist for some months while regulations pursuant to this legislation are drafted.

Procedures for selection of a response action will comply with the Comprehensive Environmental Response, Compensation and Liability Act (CERCLA), and recently-enacted amendments to that act known as the Superfund Amendments and Reauthorization Act of 1986 (SARA). Pursuant to these statutes, this task will comply fully with the National Contingency Plan (NCP) found in 40 Code of Federal Regulations (CFR) 300 as revised by 50 Federal Register (FR) 47912 (November 20, 1985), effective February 18, 1986. Additional applicable guidance for these regulations is found in "Guidance on Feasibility Studies Under CERCLA", issued June 1985 (U.S. Environmental Protection Agency (EPA), 1985).

Among the major provisions of SARA are a variety of requirements relating to cleanup levels, the relationship of Superfund to other laws, and a new remedy selection process. Current available guidance for this law includes "Interim Guidance on Superfund Selection of Remedy" (EPA, 1986a) and the January 26, 1987 Executive Order 12580 assigning agency responsibilities for federal facilities. These documents have been used as references in Part IV - Feasibility Study. Additional EPA guidance documents for related regulations mentioned in SARA as having particular application include the Resource Conservation and Recovery Act (RCRA) corrective action strategy and "Draft Guidance on Remedial Actions for Contaminated Ground Water at Superfund Sites" (EPA, 1986b).

New regulations pursuant to SARA will be forthcoming. Foremost among these will be a revised NCP which EPA is required to finalize by early 1988 under SARA. Numerous other guidance documents and policy statements will likely be issued and will be examined and incorporated in the program as appropriate, after consultation with EPA, the Program Manager's Office for Rocky Mountain Arsenal (PMO-RMA), and the Department of Justice (DOJ) on interpretation and applicability.

Until the new policies and guidance documents are formalized, this offpost remedial selection process will continue as outlined in the enclosed Technical Plan. Because the selection process includes an RI, an Endangerment Assessment (EA), and an FS, the Technical Plan is organized corresponding to these activities as follows:

- Part I - Introduction (Section 1.0);
- Part II - Remedial Investigation (Section 2.0 through 8.0);
- Part III - Endangerment Assessment (Section 9.0);
- Part IV - Feasibility Study (Section 10.0); and
- Part V - Management and Adminstration (Section 11.0).

The Introduction presents project background and sets forth the objectives of this study. Part II is the RI. The main purpose of the RI is to collect additional data in the study area to better define hydrogeologic conditions

and patterns of contaminant migration as input to the EA and FS. The scope of the RI consists of a Geotechnical Program, Ground-Water Sampling, Chemical Analysis, Quality Assurance, Data Management Program, and a Safety Program. Part III is the EA in which the magnitude and probability of actual or potential harm to pubic health, welfare, or the environment from ground and surface water contaminants offpost of RMA is characterized. Part IV is the FS which will include the assessment of alternatives based upon the results of the RI and EA. Remedial action alternatives will be developed to mitigate risk and harm to the public health, welfare, and damage to the environment. The FS will only consider RMA-originated compounds. Part V includes a discussion of proposed Management Plan for maintenance of this task.

PART I -- INTRODUCTION (SECTION 1.0)

1.0 INTRODUCTION AND BACKGROUND

The U.S. Army Toxic and Hazardous Materials Agency (USATHAMA) has issued Contract No. DAAK11-84-D-0016, Task Order 39 to Environmental Science and Engineering, Inc. (ESE) to assist the Army in conducting additional Remedial Investigations (RI), to conduct an Endangerment Assessment (EA), and to perform a Feasibility Study (FS) offpost of Rocky Mountain Arsenal (RMA). This Technical Plan presents procedures, methodology, analytical techniques, and rationale for the technical effort in the work elements of geotechnical data collection and evaluation, ground-water sampling, chemical analysis, data analysis, risk assessment, and remedial action alternatives development and evaluation. This Technical Plan will serve as a reference document for personnel conducting field activities, data analysis, risk assessment, remedial action alternatives assessment, and report preparation.

The primary authorization for an offpost RI/FS at the RMA is the Army's response authority under the Comprehensive Environmental Response, Compensation, and Liability Act of 1980 (CERCLA) as amended. As delegated by Executive Order 12580, the Army is responsible for determining response measures, consistent with the National Contingency Plan (NCP), deemed necessary to protect public health, welfare, or the environment from releases of hazardous substances, pollutants, or contaminants from Army facilities. As a first step in determining offpost response measures, the Army initiated a Contamination Assessment Program in July 1984 to determine the nature and extent of contamination in offpost areas.

The NCP was most recently revised by 50 Code of Federal Regulations (CFR) 47912. This citation contained some significant revisions to the NCP which became effective February 18, 1986. The latest applicable U.S. Environmental Protection Agency (EPA) guidance document is "Guidance on Feasibility Studies Under CERCLA", issued June 1985 (EPA, 1985). This guidance will be applied to the extent that it remains valid in light of the NCP revisions.

On October 17, 1986 the President signed into law the "Superfund Amendments and Reauthorization Act of 1986" (SARA). This act amends and extends the CERCLA legislation. Among its major provisions are a variety of requirements relating to cleanup levels, the relationship of Superfund to other laws, and a modified method process for selection of remedial actions. Current available guidance for this law includes "Interim Guidance on Superfund Selection of Remedy" (EPA, 1986a) and Executive Order 12580, signed on January 26, 1987, which assigns agency responsibilities for federal facilities. Pursuant to this Executive Order, the lead responsibility for conducting this offpost RI/FS may now rest with EPA. The scope of EPA's responsibility in this regard is currently the subject of discussions between EPA and the Army. In the event EPA assumes lead responsibility for this offpost RI/FS, the Army will continue to implement the RI/FS tasks set out in this Technical Plan, subject to EPA's ultimate approval authority, at least with respect to offpost contaminants that clearly originated from the arsenal.

There are three major tasks under this plan of study. The first task is an RI which will include an investigation to define contaminant transport in the environment. This will include site selection, drilling, logging, borehole geophysics, well installation, well development, surveying, water sampling, and water level measurements. The second task involved in this study is an EA which will evaluate exposure and risk to the public health and the environment from RMA contaminants. The third major task involved in this study is an FS. The data and other information developed pursuant to this Technical Plan will serve as a reference document for the development of remedial action alternatives, the screening of alternatives, and the detailed evaluation of alternatives. The result of the RI/FS will be support information for a Record of Decision (ROD) addressing offpost contamination and justifying any remedial actions that may be appropriate.

The specific objectives of the RI/FS include:

- o Collect additional data to refine the current understanding of ground-water flow patterns and the distribution of contaminants;

- Evaluate the danger posed to humans living in the study area and also evaluate environmental impacts using current knowledge of the concentrations and distributions of contaminants on the offpost ground-water system;
- Develop a range of remedial alternative which would mitigate public health and environmental impacts;
- Evaluate the candidate remedial alternatives with respect to technical factors, cost efficiency, and the extent to which they mitigate public health and environmental impacts; and
- Select a preferred remedial alternative based on the alternatives assessment.

Consistent with interim NCP guidelines for evaluating and selecting remedial action, each of these elements will be interactive to assure that the study is complete and accurate.

Task 39 is supported by and dependent upon other onpost and offpost investigations at RMA. Specifically, these tasks include:

- Task 1 -- Section 36;
- Task 4 -- Ground Water/Surface Water;
- Task 9 -- Biota Assessment;
- Task 16 -- Report on an Accelerated Cleanup Plan for the Contamination at RMA;
- Task 18 -- Air Monitoring;
- Task 19 -- Basins Area - Phase II;
- Task 25 -- Boundary Control System Monitoring;
- Task 35 -- RMA Endangerment Assessment;
- Task 36 -- North Boundary System Component Response Action Assessment; and
- Task 44 -- Ground Water/Surface Water Continuation.

The importance of each task and impacts from these tasks are discussed in appropriate sections of this Technical Plan.

1.1 STATEMENT OF THE PROBLEM

1.1.1 ONPOST CONDITIONS

RMA occupies over 17,000 acres in Adams County, Colorado (Figure 1.1-1). RMA is located approximately 8 to 10 miles (mi) northeast of the center of downtown Denver.

There are numerous sites on RMA where hazardous wastes have been spilled, stored, and disposed. Industrial waste effluents generated at RMA were routinely discharged to unlined evaporation basins. Solid wastes have been buried at various locations throughout RMA. Unintentional spills of raw materials, and intermediate and final products, have also occurred within the manufacturing complexes at RMA. Contaminants released as a result of these activities have occasionally entered media such as ground water, surface water, air, or wildlife, and have become mobile.

Presented below is a listing of the compounds and chemical species that have been identified as ground-water contaminants on RMA by the U.S. Army Corps of Engineers (COE) Waterways Experiment Station (WES) (Spaine et al., 1984, RIC#85133R04):

- Volatile organics;
- Chlorinated pesticides (aldrin, dieldrin, endrin, isodrin);
- Dibromochloropropane (DBCP);
- Diisopropylmethylphosphonate (DIMP);
- Dicyclopentadiene (DCPD);
- Chloride;
- Fluoride;
- 1,4-Dithiane/1,4-Oxathiane; and
- p-Chlorophenylmethyl Sulfone ($PCPMSO_2$)/Sulfoxide (PCPMSO)/Sulfide (PCPMS).

1.1.2 OFFPOST CONDITIONS

A number of these onpost contaminants have been detected in offpost ground water by previous studies which were conducted to assess the extent and nature of offpost contamination. In particular, the Rocky Mountain Arsenal Offpost Assessment Contamination Assessment Report (CAR) (ESE, 1987,

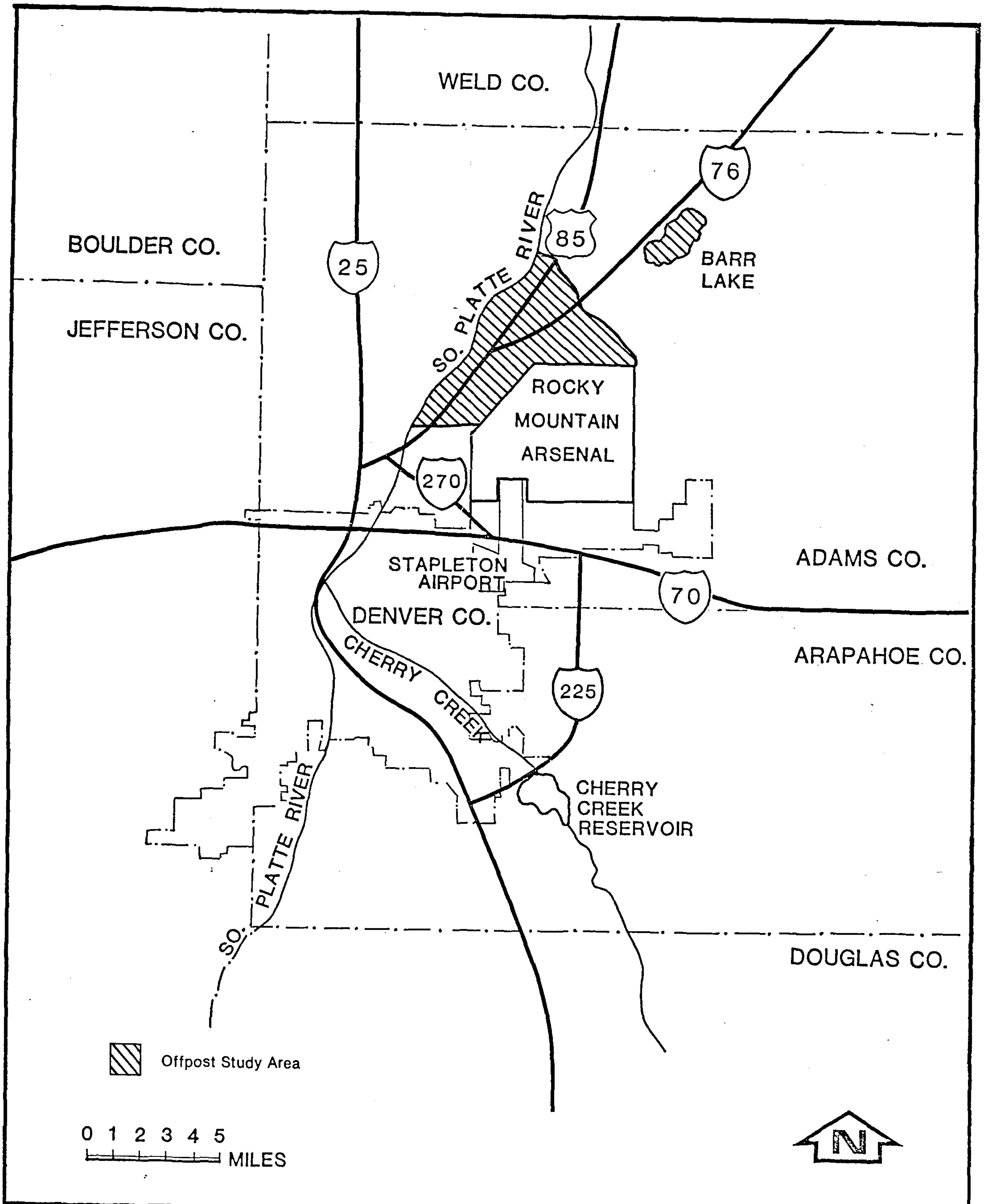

Figure 1.1-1
LOCATION MAP

SOURCE: RMA, 1983

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U.S. Army Program Manager's Office
For Rocky Mountain Arsenal
Aberdeen Proving Ground, Maryland

RIC#87202R01) utilizes data from several studies to provide a comprehensive view of the distribution and level of offpost contamination to the north and northwest of RMA. The most widespread of the organic contaminants detected in the offpost study area was DIMP. DIMP is primarily migrating off of RMA along the northern boundary via ground water and surface water. Because of its high mobility and persistence in the study area, DIMP has proved to be a good delineator of migration pathways. Other organic contaminants have also been detected in the offpost study areas. These include organochlorine pesticides, organosulfur compounds, volatile organics, DBCP, and DCPD. With the exception of DIMP and other isolated detections, these contaminants have been more confined to areas immediately north and northwest of RMA.

In the offpost CAR study area, chloride and fluoride, naturally occurring inorganic constituents, have been detected at concentrations exceeding secondary and primary drinking water standards, respectively. In particular, chloride has migrated from RMA's northern boundary and has been routinely found at elevated levels in areas to the north and northwest of the RMA northern boundary. Section 1.4 explains more fully the offpost ground-water contamination.

1.2 ONGOING RESPONSE ACTIONS

A number of contamination control measures have been implemented at RMA and additional control measures have been planned or are proposed. With regard to controlling the migration of contaminants to offpost areas, three major containment/treatment systems have been installed. Based upon the chemical analyses performed on the systems' influent and effluent, these systems have been very successful in removing and treating substantial amounts of contaminated ground water at RMA boundaries. These systems are described briefly in the following paragraphs.

1.2.1 NORTH BOUNDARY: CONTAINMENT/TREATMENT

The containment system installed at the north boundary of RMA consists of a physical barrier (slurry wall), dewatering wells to intercept the natural flow of ground water exiting along the northern boundary, a ground-water

treatment system to remove organic contaminants, and recharge wells to recharge treated water.

1.2.2 NORTHWEST BOUNDARY: CONTAINMENT/TREATMENT

The containment system at the northwest boundary utilizes a physical barrier (slurry wall), and a hydrologic control system consisting of dewatering wells, a water treatment system, and recharge wells. The system at the northwest boundary employs a combination of technologies used in the north boundary and Irondale systems.

1.2.3 IRONDALE: CONTAINMENT/TREATMENT

A hydrologic control system is installed at the southern part of the northwest boundary, referred to as the Irondale area. This control system consists of two rows of dewatering wells, one row of recharge wells, and a water treatment facility for removal of organic contaminants.

1.3 STUDY AREA

Previous investigations at RMA, including the offpost CAR, have determined that contaminants were migrating offpost primarily by movement with ground water through alluvial and uppermost Denver sandstone units and by flooding of surface features. Ground and surface water movement from RMA is generally from the northern boundary to the northwest in the direction of the South Platte River. Based upon known areas of on and offpost contamination and the predominate ground and surface water flow patterns, the study area for the offpost RI/FS is the area between the north and northwest boundaries of RMA and the South Platte River. The specific boundaries of the study area are the same as for the offpost CAR as shown in Figure 1.3-1 and described below:

- o Southeast Boundary - north and northwest boundaries of RMA;
- o Southwest Boundary - 80th Avenue;
- o West and Northwest Boundary - the South Platte River; and
- o Northeast Boundary - Second Creek.

The area that was chosen was based upon a conservative estimate of the area within which contaminants from the arsenal may now or eventually come to

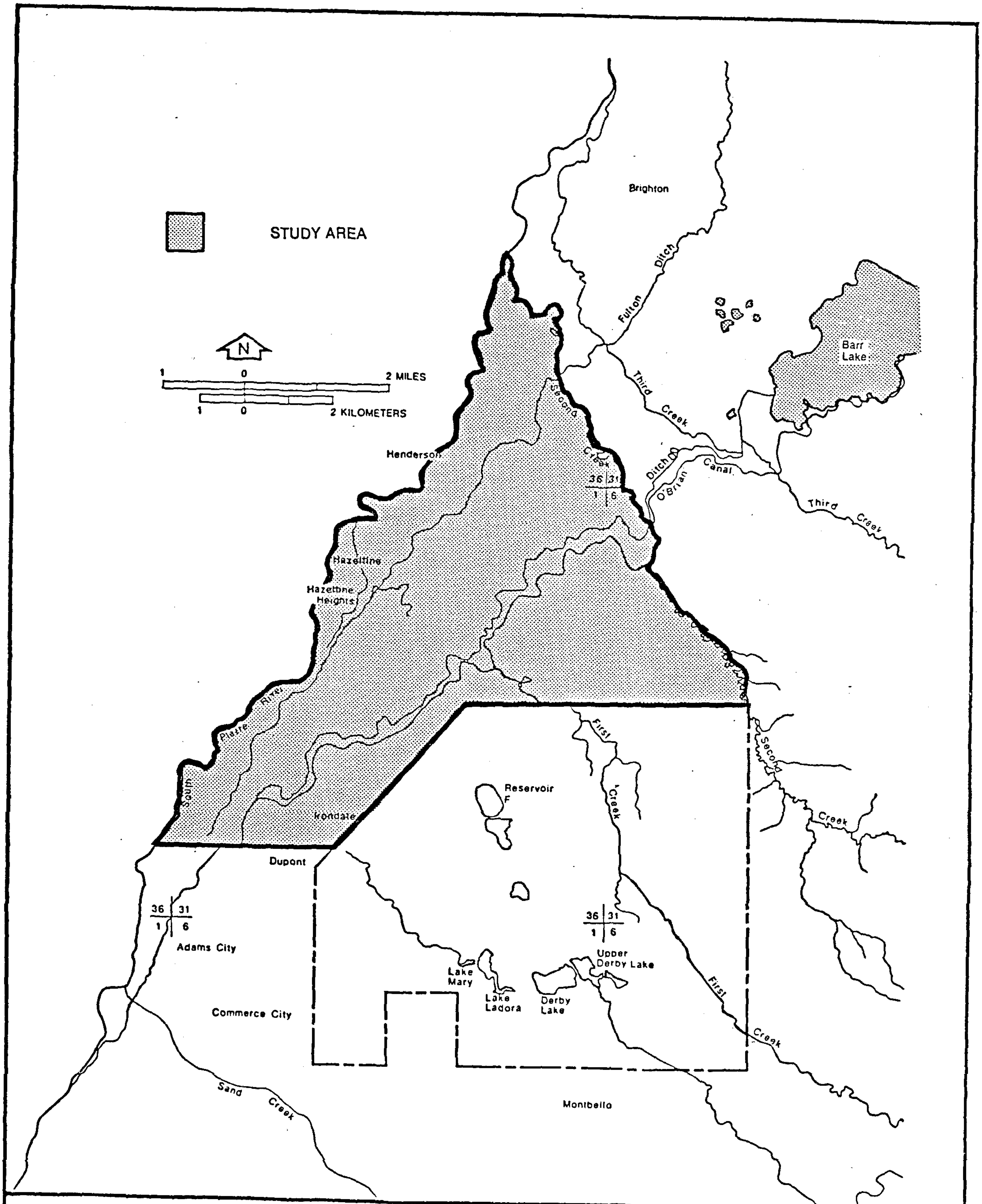

Figure 1.3-1
OFFPOST STUDY AREA

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rest. However, based upon hydrologic and hydrogeologic considerations, most of this area is not expected to be contaminated by materials originating from RMA. In order to emphasize areas where impact to the public and environment is most likely, the study will focus on those areas which were defined in the offpost CAR as being zones of higher contamination. Barr Lake has also been included in the study area because of the potential for contaminant migration through surface water features. These areas will be described in more detail in Section 1.4.

1.3.1 TOPOGRAPHY AND SURFACE WATER HYDROLOGY

The topography to the north and northwest of RMA consists of stream-valley lowlands separated by gently rolling uplands. The overall surface drainage in the region is toward the northeast and all of RMA is drained by the South Platte River and its tributaries. The South Platte River originates in the Rocky Mountains southwest of Denver, and then flows in a general north-northeast direction to the vicinity of Greeley, where it flows toward the east.

The study area contains parts of several drainage basins as shown in Figure 1.3-2. Proceeding from southwest to northeast, these basins are Sand Creek, Irondale Gulch, Northwest, First Creek, and Second Creek. All these areas are sub-basins in the South Platte River drainage. The South Platte River flows northeasterly at a distance of approximately 3 mi from the RMA northwest boundary.

Two major irrigation canals, O'Brian Canal and Burlington Ditch, as well as several smaller ditches run southwest to northeast between RMA and the South Platte River. Water from First Creek and Second Creek flows into O'Brian Canal. The Second Creek drainage continues to the South Platte River, but all upstream flow is intercepted by O'Brian Canal. These flows are either stored in the reservoir at Barr Lake State Park or distributed into one or more of many irrigation ditches downstream, depending on the season and the quantity of water available.

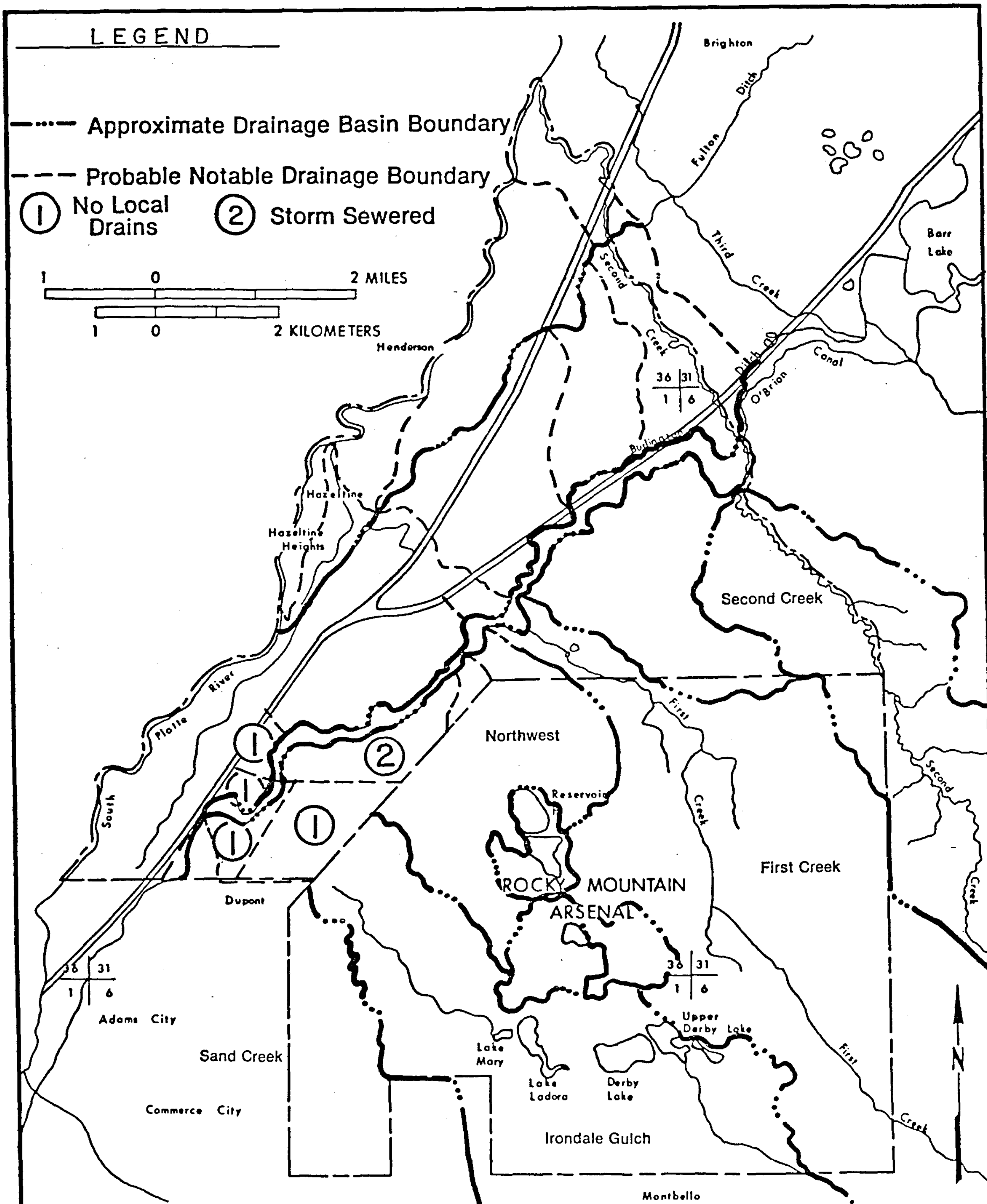

Figure 1.3-2
DRAINAGE BASINS

REF. RESOURCE CONSULTANTS, INC. 1986

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1.3.2 PRECIPITATION

The RMA is generally classified as a mid-latitude, semi-arid climate. This indicates an area with hot summers and cold winters. Precipitation in the general region is approximately 15 inches per year with approximately 80 percent falling between April and September. Snow and sleet usually occur from September to May with the heaviest snowfall in March and possible trace accumulations as late as June. Thunderstorms occur frequently in the region and are generally accompanied by heavy showers, severe gusty winds, frequent thunder and lightning, and occasional hail. There are approximately 93 days per year with a cloud cover of 30 percent or less.

1.3.3 GEOLOGY

RMA is located within the geologic province of the Denver Basin, a structural depression resulting from tectonic adjustments. The basin exhibits an elongate, north-south trending surface expression, 300 mi long and 200 mi wide in north-central Colorado, Wyoming, and Nebraska (Figure 1.3-3). Sedimentary strata composed of conglomerate, sandstone, shale, and limestone lithologies rest on the Precambrian basement and fill the synclinal structure (Figure 1.3-4). Strata range in age from Cambrian to Quaternary.

The study area lies on a bedrock surface formed by the late Cretaceous-Early Tertiary Denver Formation (Fm). Quaternary alluvial and eolian deposits mantle the surface and obscure the Denver Fm (Figure 1.3-5). Regional dip is to the southeast.

The basin acquired its present configuration during the late Cretaceous-Tertiary Laramie Orogeny. Normal faulting, regional uplifting, mountain glaciation, and development of the present drainage system characterize the late Tertiary to recent history of the study area. The episodes caused extensive erosion which removed great quantities [up to 1,400 feet (ft)] of the Denver Fm and carved the paleochannels which underlie the surficial deposits (Costa and Bilodeau, undated, RIC#82308R01).

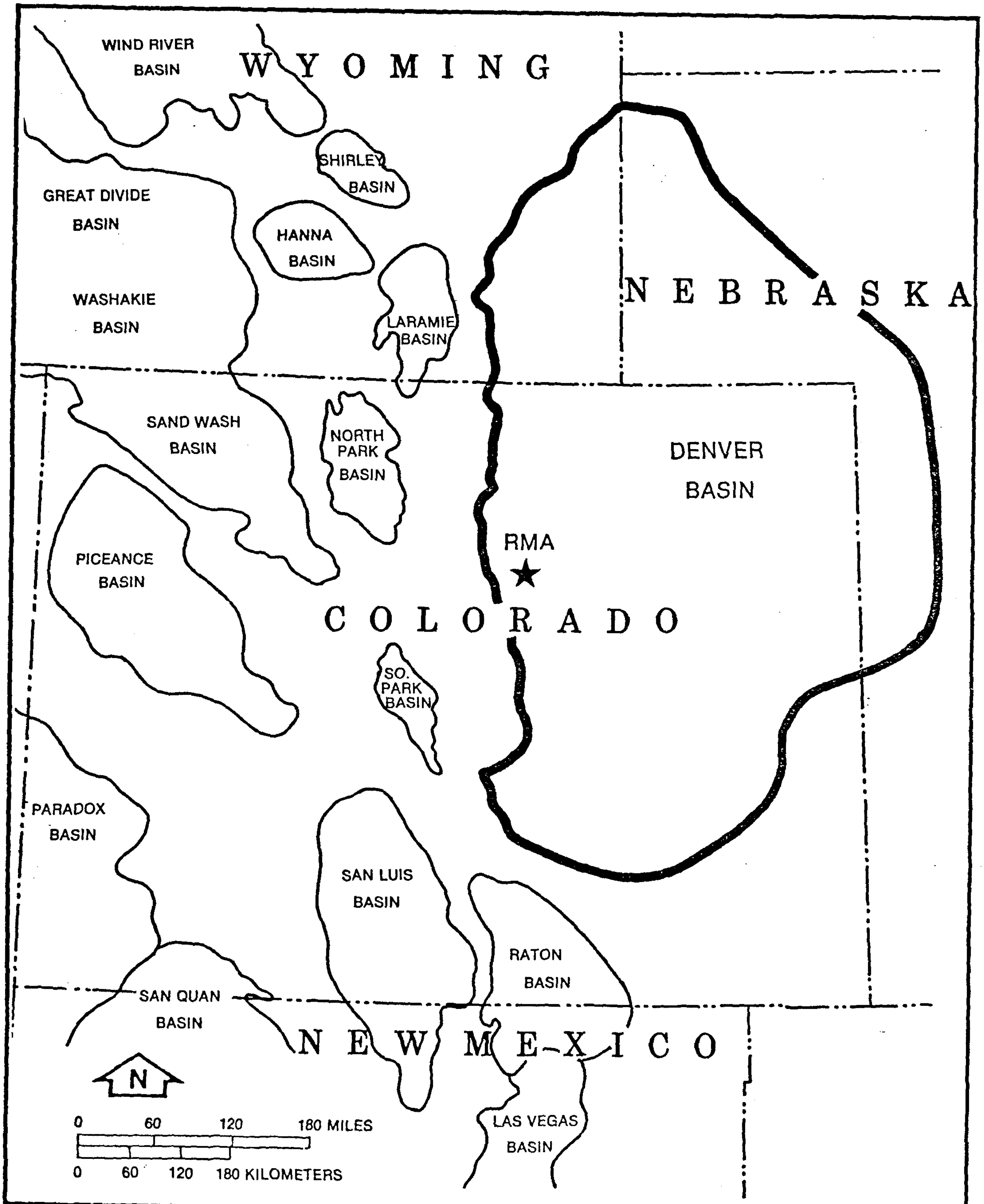

Figure 1.3-3
MAJOR STRUCTURAL ELEMENTS OF THE SOUTHERN ROCKY MOUNTAINS
SOURCE: RMAG, 1972

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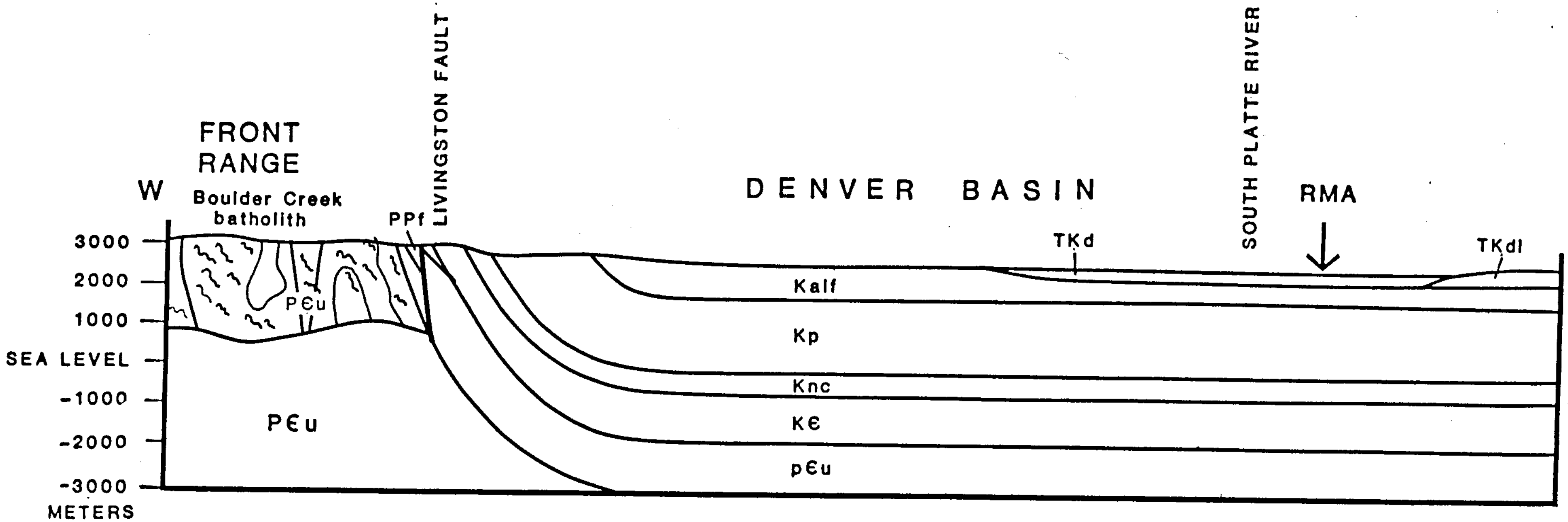

TKdl DAWSON ARKOSE (TERTIARY - UPPER CRETACEOUS)
TKd DENVER FORMATION (TERTIARY - UPPER CRETACEOUS)
Kalf ARAPAHOE FORMATION, LARAMIE FORMATION, FOX HILLS SANDSTONE (UPPER CRETACEOUS)
Kp PIERRE SHALE (UPPER CRETACEOUS)
Knc NIOBRARA FORMATION, CARLILE SHALE, GREENHORN LIMESTONE, GRANEROS SHALE
KЄ DAKOTA SANDSTONE(UPPER CRETACEOUS) AND UNDERLYING MESOZOIC PALEOZOIC ROCKS (UPPER CRETACEOUS)
PPf FOUNTAIN FORMATION (PERMIAN - PENNSYLAVANIAN)
PЄu PRECAMBRIAN UNDIFFERENTIATED

Figure 1.3-4
GEOLOGIC CROSS SECTION

SOURCE: ESE, 1987

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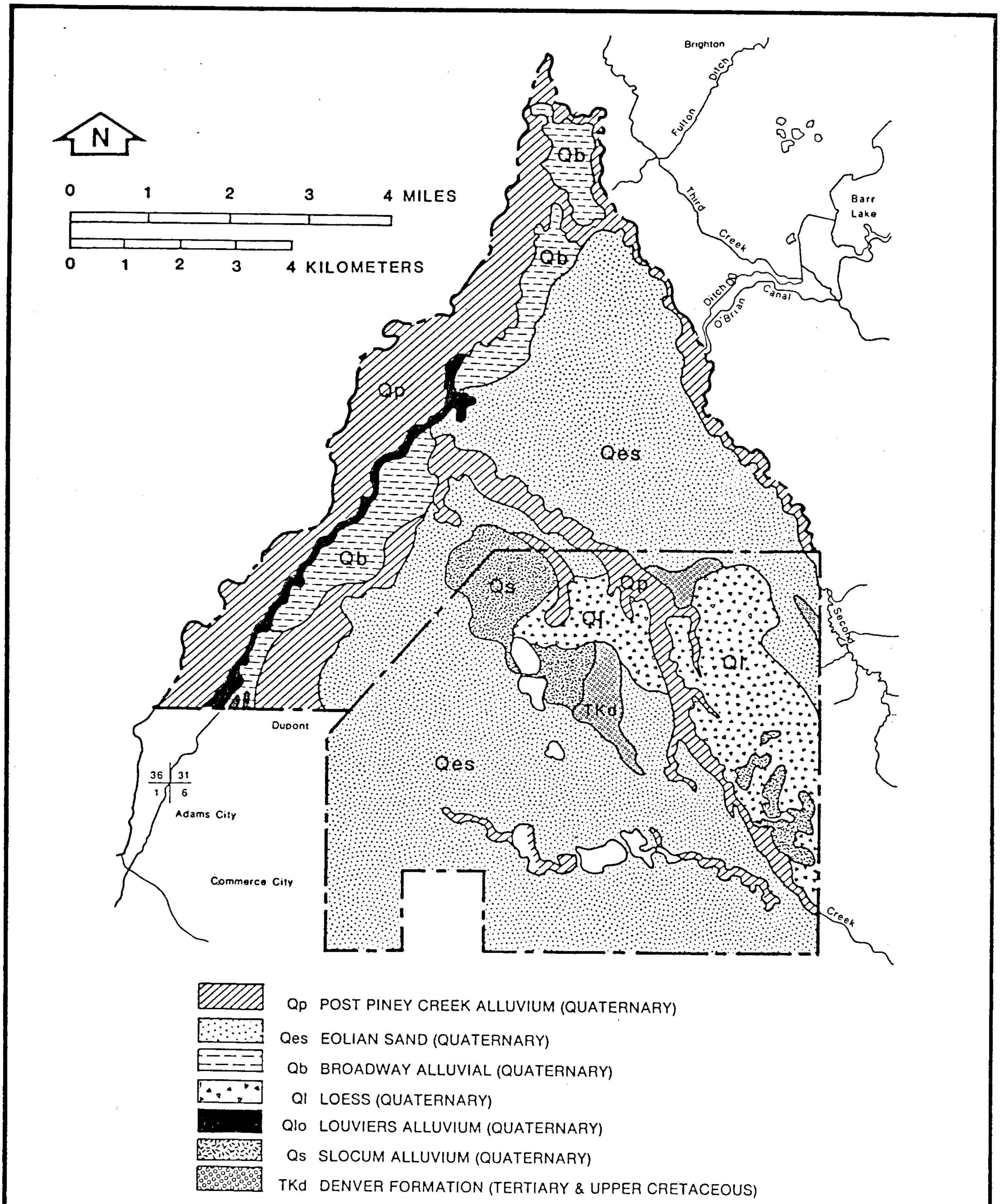

Figure 1.3-5
GEOLOGIC MAP OF
ROCKY MOUNTAIN ARSENAL AREA

SOURCE: USGS, 1981

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For Rocky Mountain Arsenal
Aberdeen Proving Ground, Maryland

1.3.4 GEOHYDROLOGY

Ground-water resources within the RMA offpost study area are classified as part of the Denver ground-water basin. As illustrated in Figure 1.3-6, the basin underlies the area extending from Greeley, Colorado in the north to Colorado Springs, Colorado in the south and from the Front Range Uplift on the west to near Limon, Colorado on the east. Formations ranging in age from Pennsylvanian to Tertiary contain water bearing units. The four major bedrock aquifers are the Laramie-Fox Hills, Arapahoe, Denver, and Dawson. Surficial deposits as well as crystalline rocks of the Front Range locally yield sufficient quantities of water to be considered aquifers.

The geologic formations containing the four major bedrock aquifers are the Fox Hills Sandstone, the Laramie and Arapahoe Fms of Late Cretaceous Age, the Denver Fm of Late Cretaceous and Early Tertiary Age, and the Dawson Arkose of Tertiary Age (Romero, 1976, RIC#81266R69). These formations occur in a sequence of layers as shown by the generalized geologic sections drawn from west to east and from south to north through the basin (Figure 1.3-6). The northern, eastern, and southern parts of the basin form a shallow bowl, the sides of which dip gently toward the west-central part of the basin. Along the western edge of the basin, sedimentary formations are upturned along the Precambrian crystalline rocks of the Front Range and dip steeply to the east as a result of faulting and the gradual upward movement of the Rocky Mountains. The Pierre Shale of Late Cretaceous Age underlies the Fox Hills Sandstone. The top of this shale is considered to be the base of this major bedrock-aquifer system due to its great thickness and its minimal permeability (Robson and Romero, 1981, RIC#82350M02).

The strata of primary concern in the RMA offpost study area are the Arapahoe Fm, Denver Fm, and unconsolidated Quaternary alluvial and eolian surficial deposits. Aquifers within these units comprise the ground-water regime of interest in the study area.

Surficial Deposits

Sediments present at the land surface consist of unconsolidated alluvial and eolian deposits of Quaternary age. The material is composed primarily of

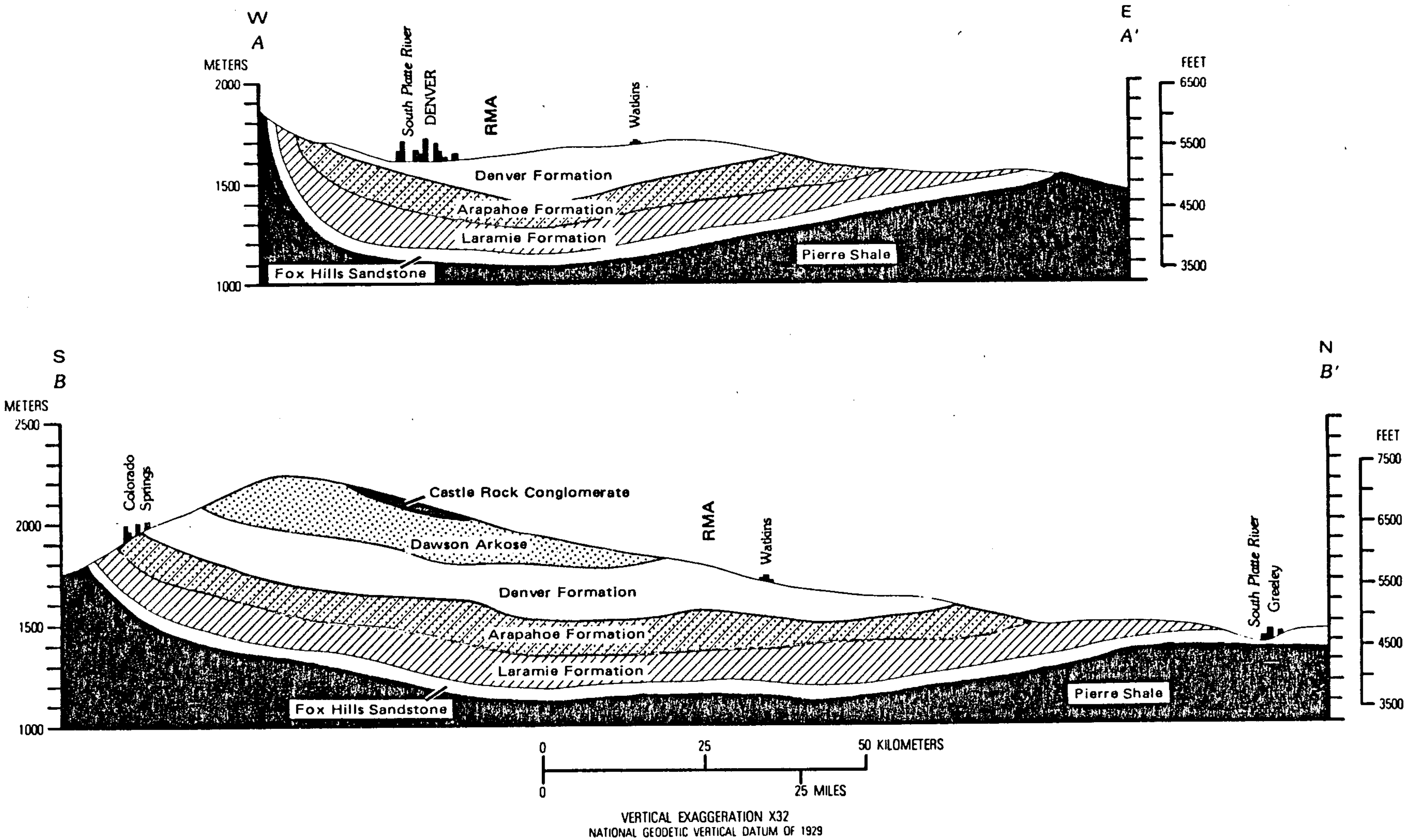

Figure 1.3-6
UPPER STRATIGRAPHIC SECTIONS OF DENVER BASIN

SOURCE: ROBSON, 1981

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Aberdeen Proving Ground, Maryland

valley fill, dune sand, and terrace gravel which contains cobbles, boulders, and beds of volcanic ash as well as sands, gravels, silts, and clays. Combined thickness of the surficial materials ranges from 30 to 130 ft. Thicker deposits represent filling of paleochannels cut in the surface of the Denver Fm. A preliminary structure contour map constructed for the top of the bedrock surface delineates these paleochannel depressions (Figure 1.3-7). Lithologic logs from boreholes drilled in the intrachannel areas indicate anomalously thick sequences of overburden prior to penetrating the Denver. Colors range from yellow-brown to pale orange and are a product of oxidation. Local deposits may be consolidated where calcium carbonate has cemented sands and gravels to form conglomerates.

The entire sequence of surface materials should be considered water bearing. Overall permeability of the deposit is enhanced by the general coarse nature of the materials, especially in the paleochannels where the bulk of the fill consists of gravels, cobbles, and boulders. Paleochannels most likely serve as major ground-water transport pathways in the study area.

The ground-water regime in the offpost area is relatively complex due to unique hydrologic, stratigraphic, and topographic relationships between the Arapahoe and Denver Fms and the overlying surficial deposits. A water table contour map for the alluvial aquifer is presented in Figure 1.3-8. Ground water in an isotropic aquifer will flow perpendicular to hydraulic contours from areas of high potentiometric or water table elevation to areas of low water table elevation.

Denver Formation

The Denver Fm unconformably overlies the Arapahoe Fm. Within the basin, the Denver Fm varies in thickness from 230 to 400 ft. In the offpost area, the Denver Fm ranges from approximately 230 ft at the north boundary of RMA to 0 ft where it pinches out. The formation consists of olive, bluish grey, green gray, and brown clay, shale, and siltstone interbedded with poorly sorted, weakly lithified tan to brown, fine- to medium-grained, lenticular sandstone and conglomerate. Lignite beds and carbonaceous shales are common, and to a lesser degree are volcanic fragments and tuffaceous

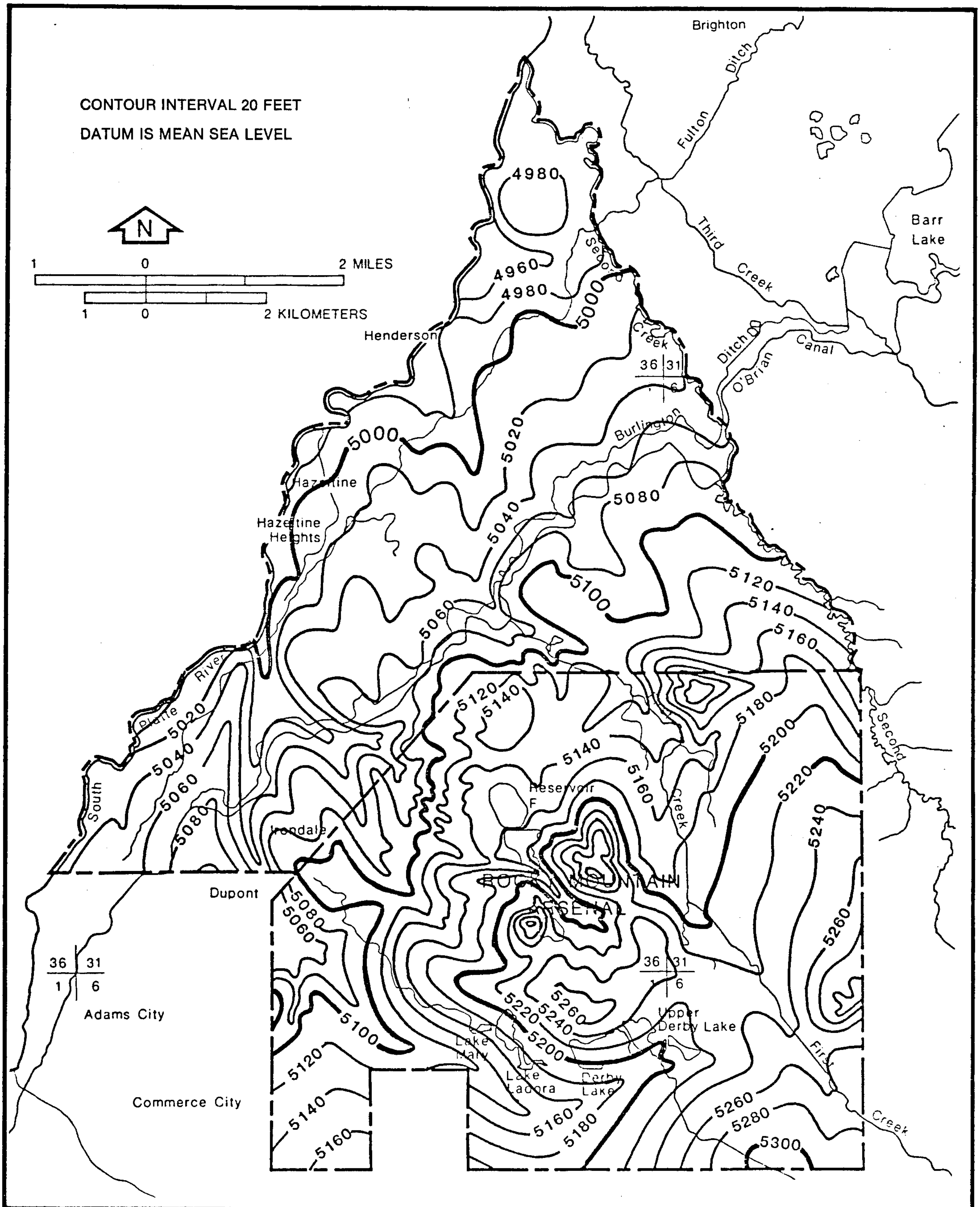

Figure 1.3-7
ELEVATIONS OF BEDROCK SURFACE

SOURCE: ESE, 1987

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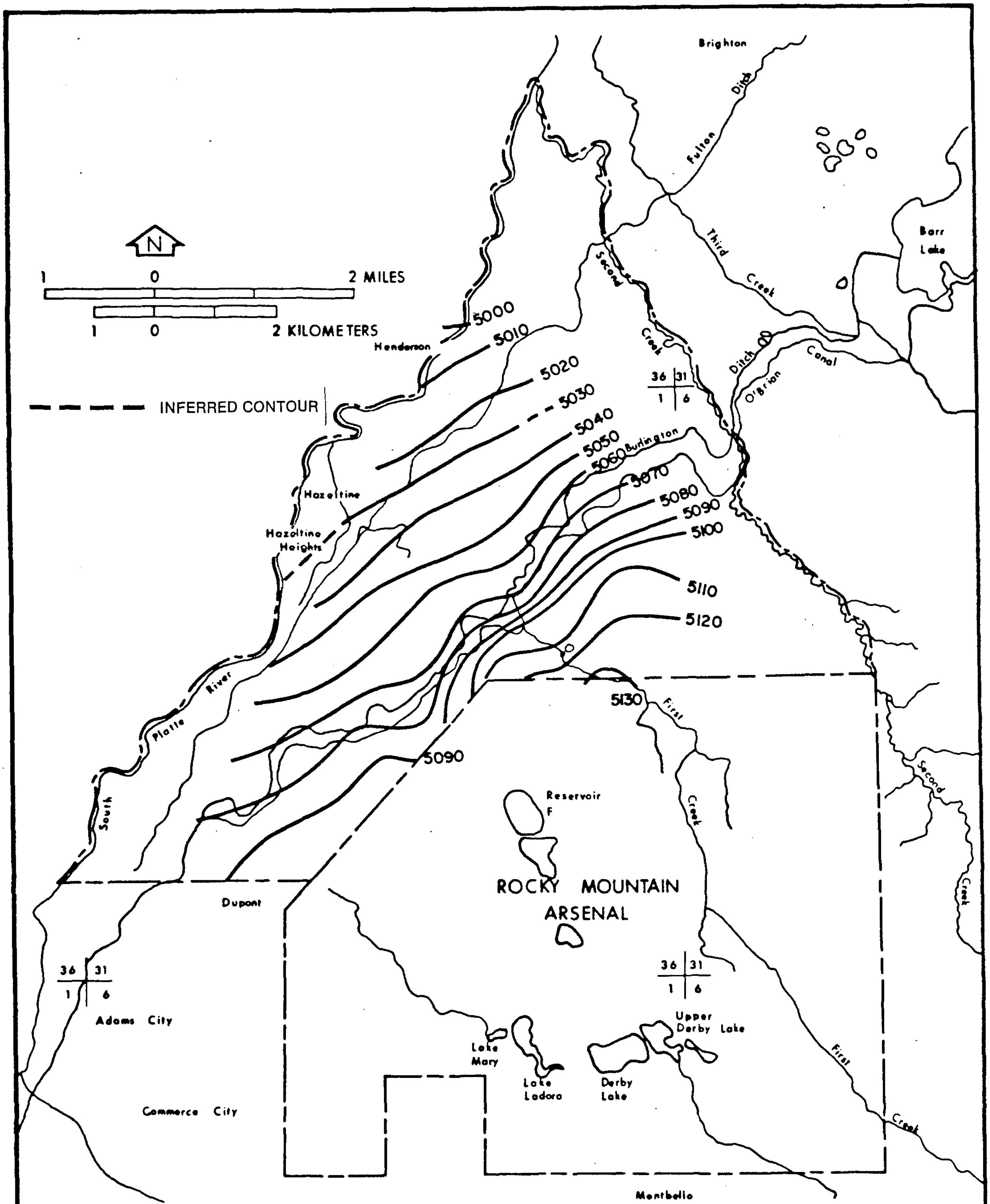

Figure 1.3-8
NOVEMBER-DECEMBER 1985 ALLUVIAL GROUND WATER LEVEL CONTOUR MAP, ROCKY MOUNTAIN ARSENAL OFFPOST STUDY AREA
SOURCE: ESE, 1987

Prepared for:
U.S. Army Program Manager's Office For Rocky Mountain Arsenal
Aberdeen Proving Ground, Maryland

materials. Minor beds of bentonite may also be present. The predominant olive and green-gray colors resulting from erosion and weathering of andesitic and basaltic lavas help distinguish the formation from the underlying lighter colored Arapahoe Fm.

Water bearing zones in the formation are restricted to sandstone lithologies that are lenticular in nature. These lenses are irregularly distributed within thick clay-shale sequences. They are discontinuous and therefore difficult to trace, and are poorly defined where sandstones grade into encompassing clay and shale. Sandstone lenses range in thickness from a few inches to as much as 65 ft. Ground-water flow occurs within void spaces between coarser sand grains in sandstones, while little water is able to flow through finer silt and mud components of the clay and shale (Robson et al., 1981, RIC#82293M02).

Arapahoe Formation

The Arapahoe Fm is a 400- to 700-ft thick sequence of interbedded conglomerate, sandstone, siltstone, and shale. The formation can be divided into two parts. Sandstone and conglomerate with thin beds of shale characterize the lower portion, while a predominantly blue to gray shale with minor lenses of sandstone and ironstone concretions marks the upper. The conglomerates, sandstones, and siltstones range from white to medium grey with some local yellow-green beds. Shales are commonly silty. The Arapahoe is distinguished from the overlying Denver Fm by the larger proportion of conglomerate and sandstone with respect to shale, the absence of significant carbonaceous materials, and an overall lighter color distinguish.

Individual conglomerate and sandstone beds in the Arapahoe Fm are commonly lens shaped and range in thickness from a few inches to 40 ft. The beds may be so closely spaced that they form a single hydrologic unit that is 200- to 300-ft thick in some areas. Generally, the conglomerates and sandstones are only moderately consolidated and are of coarser grain than the siltstones and shales. This allows ground water to flow through the void spaces between grains of gravel and sand in the conglomerate and sandstone, while

little or no water is able to flow through the siltstone and shale (Robson et al., 1981, RIC#82293M02).

1.3.5 LAND USE AND BIOTA

Most of the land within the study area has undergone considerable disturbance as a result of human occupation and development. The municipality of Commerce City is located immediately west of RMA and is currently in industrial, commercial, and residential use. North of RMA most of the land is developed for dryland agriculture. Livestock grazing, dryland crops, feedlots, and rural residential uses predominate. The area northeast of Commerce City is a major transportation corridor. Although natural areas are small and most are highly disturbed, the area offers suitable habitat for a variety of wildlife species.

1.4 OFFPOST CONTAMINATION ASSESSMENT REPORT

The Offpost CAR (ESE, 1987, RIC#87202R01) summarizes the findings of the Consumptive Use - Phase I and II studies (ESE, 1985c, RIC#87016R02 and 1986b, RIC#87016R03) and the results of the Revision III - 360^{o} Monitoring Program (ESE, 1986c, RIC#87016R05). The Consumptive Use - Phase I sampling program was conducted December 1984 through January 1985, and sampling for the Consumptive Use - Phase II program was conducted in September and October 1985. Sampling for the Revision III - 360^{o} Monitoring Program was accomplished in December 1985 and March through April 1986. These studies provide a comprehensive assessment of contamination in the offpost study area.

DIMP and chloride are the most widespread contaminants detected offpost. Because of their high persistence and mobility in the study area, these contaminants have proved to be good delineators of migration pathways. With the exception of isolated detections immediately downgradient of the northwest boundary, these contaminants appear to be emanating from the north boundary of RMA.

1.4.1 GROUND-WATER QUALITY - ALLUVIAL AQUIFER

Results of the Consumptive Use-Phase I and II studies indicate a zone of DIMP contamination northwest from the RMA north boundary toward Henderson. A comparison with the bedrock surface map indicates an excellent correlation between detectable DIMP concentrations and a paleochannel which is clearly traced from the RMA north boundary along First Creek.

The relationship between DIMP concentrations detected and the First Creek paleochannel is unclear in the Hazeltine Heights area. There may be contaminant transport along a western bifurcation in the First Creek paleochannel or the contamination may be derived from a paleochannel leading northward from the RMA northwestern boundary. Samples collected during the Consumptive Use-Phase I and II studies, from alluvial wells located south of Hazeltine Heights and completed in the northwest boundary paleochannel, indicate the absence of detectable concentrations of DIMP. The absence of DIMP contamination in the northwest boundary paleochannel suggests that DIMP contamination near Hazeltine Heights is related to the First Creek paleochannel.

Results of the Revision III - 360° Monitor Program (ESE, 1986c, RIC87016R05) support results from two previous phases of the study. Figure 1.4-1 is a plot of the DIMP detections from all three sampling efforts (ESE, 1985c, RIC#87016R02; ESE, 1986b, RIC#87016R03; ESE, 1986c, RIC#87016R05). The figure suggests that DIMP is primarily migrating out of RMA along the northern boundary. A strong component is moving in a northwesterly direction, bifurcating toward Hazeltine and Henderson. A second migration pathway moves sinuously north through the study area. There appears to be a minor movement of DIMP from RMA along the northwestern boundary, but concentrations are very low in this area. However, the number of data points along the northwest boundary is too sparse to clearly define possible migration. Figure 1.4-2 is a plot of all chloride detections that are above drinking water quality criteria levels. The chloride plot strongly suggests a paleochannel migration pathway along the direction of First Creek.

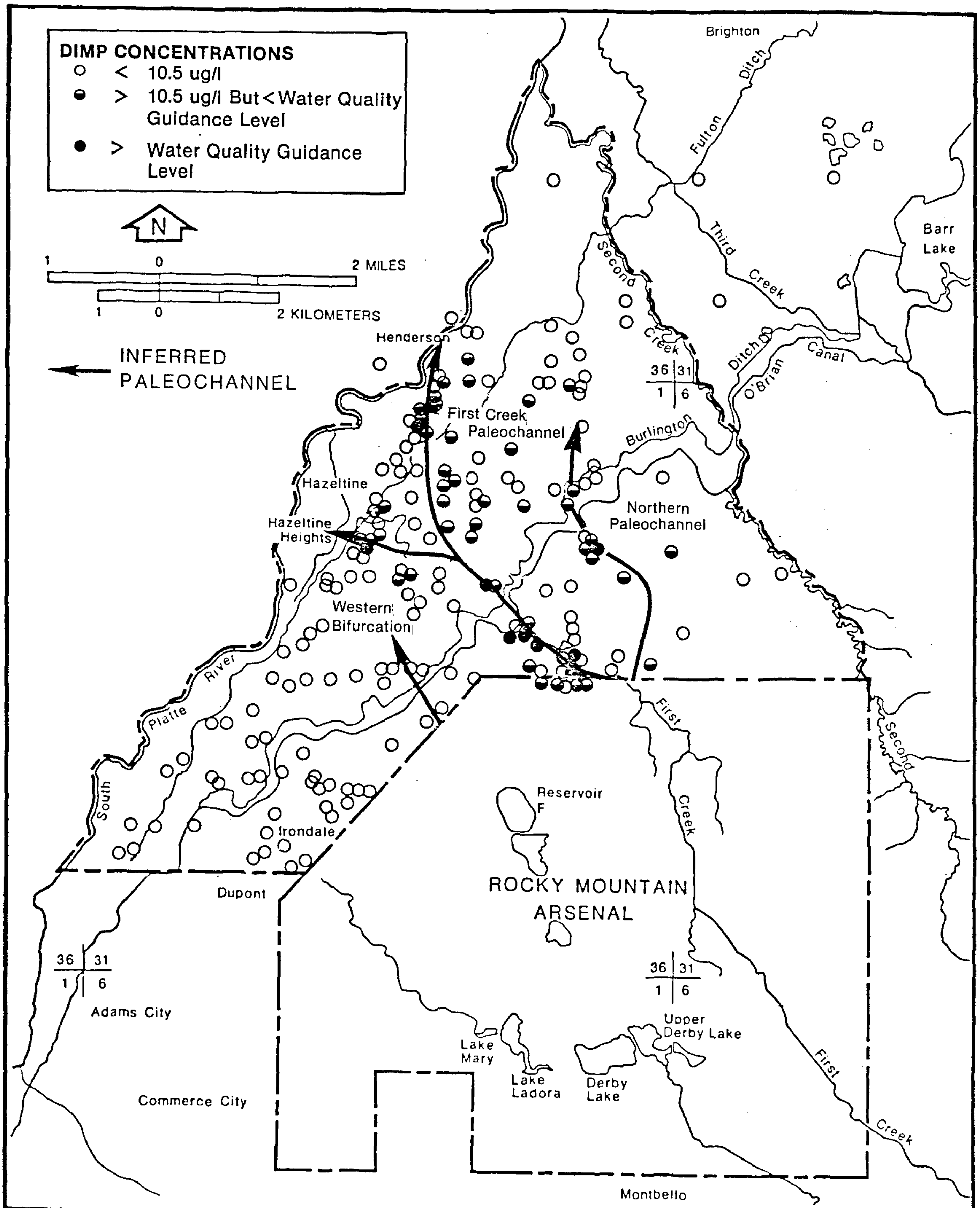

Figure 1.4-1
DIMP ASSESSMENT IN ALLUVIAL WELLS FOR CONSUMPTIVE USE-PHASE I AND II AND REVISION III-360° PROGRAMS
SOURCE: ESE,1985c; ESE,1986b; ESE,1986c

Prepared for:
U.S. Army Program Manager's Office For Rocky Mountain Arsenal
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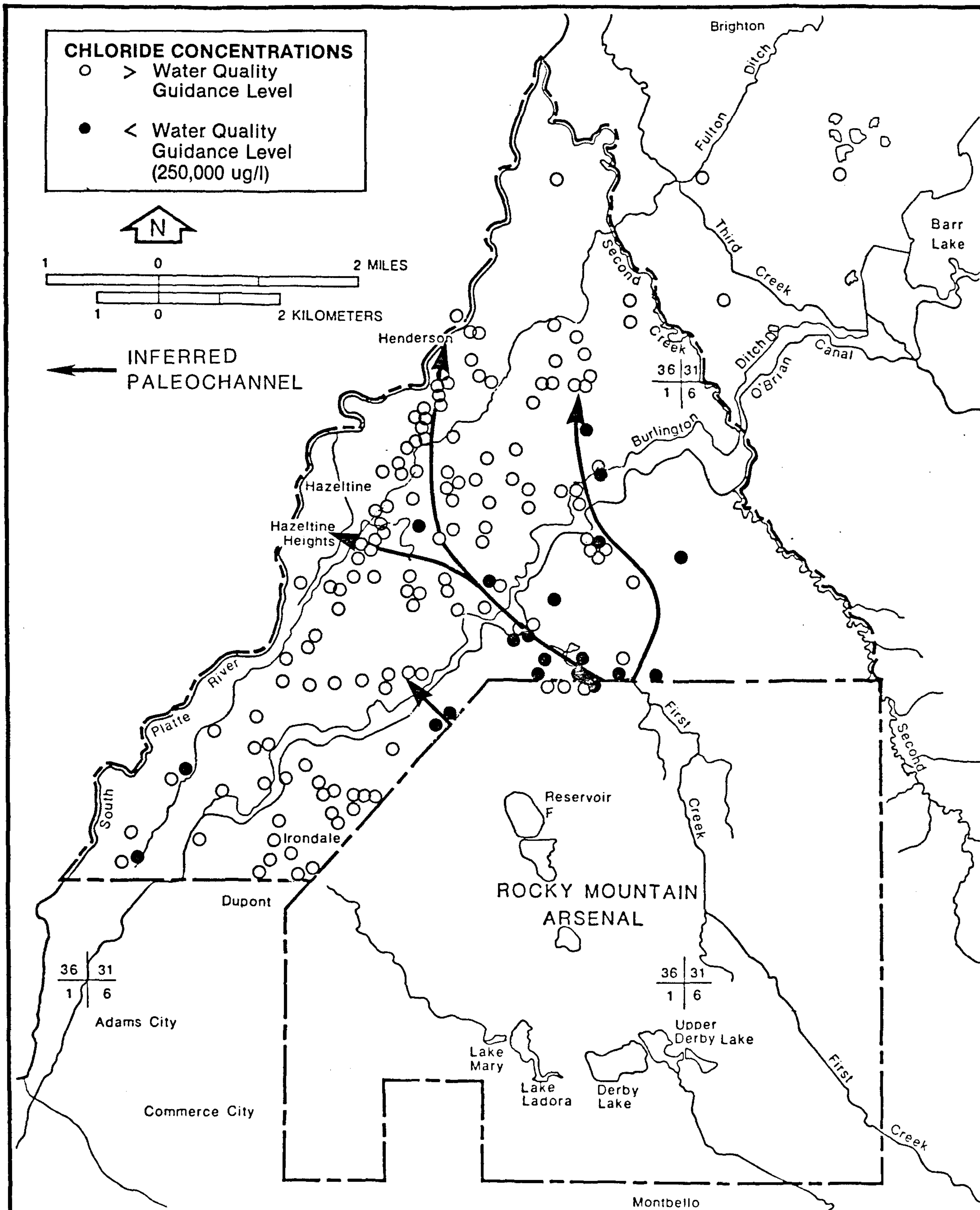

Figure 1.4-2
CHLORIDE DISTRIBUTION IN ALLUVIAL WELLS FOR CONSUMPTIVE USE PHASE I AND II AND REVISION III-360° MONITORING PROGRAMS
SOURCE: ESE,1985c; ESE,1986b; ESE,1986c

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Detections of organic solvents, chlorinated pesticides, organosulfur compounds, DBCP, and DCPD have been documented in the offpost study area. An indication of the distribution of these contaminants can be obtained by examining the figures contained in Appendix A. These figures represent the first and second quarters of sampling from the Revision III - 360° Monitoring Program (ESE, 1986c, RIC#87016R05) conducted December 1985 through January 1986 and March 1986 through April 1986, respectively. Review of the contamination distribution indicates that the most significant contamination offpost of RMA has been found within 0.5 mi of the RMA north boundary. Other significant contamination has been detected right at the RMA northwest boundary. Detections of organic solvents, chlorinated pesticides, organosulfur compounds, and DBCP have occured as much as 1.5 mi beyond the RMA north boundary. However, it is not clear if all detections of organic solvents and chlorinated pesticides are attributable to RMA.

The RI portion of this task will focus on further identification of the level and extent of migration in the contaminated area downgradient of the north boundary. Detection of the above mentioned contaminants at the northwest boundary has generally been restricted to areas immediately downgradient of the containment system. Additional monitoring efforts are being performed concurrently in Task 25 to determine if contamination has spread from the northwest boundary to areas more downgradient areas. The findings of this study will be incorporated into Task 39 as they become available to ensure that a comprehensive plan of action is developed for identifying and treating offpost contamination.

The Irondale area is characterized by detections of DBCP, benzene, trichloroethene (TCE), and other volatile organics. Based upon investigations being performed to the west of RMA by EPA, it appears that contamination may be migrating from the south into this area, therefore, some may not be attributable to RMA. Additional ground-water data are required from this area in order to better define contamination sources.

1.4.2 GROUND-WATER QUALITY - BEDROCK AQUIFERS

The Consumptive Use-Phase I study (ESE, 1985c, RIC#87016R02) described two contaminated bedrock wells out of 31 bedrock wells sampled. Both of these wells were completed in the Arapahoe Fm. No organic contamination was found in any sampled Denver Fm Wells. Lack of detectable contamination in the Denver Fm near these sites suggests that observed contamination in Arapahoe wells could be the result of cross-contamination from the alluvial aquifer caused by poor well construction or corrosion of well casings. Specific conductance, chloride, and pH values obtained from the two contaminated bedrock wells were between the values generally observed in Arapahoe and alluvial aquifers. The values support the interpretation that samples from these two wells represent a mixture of alluvial and Arapahoe ground water.

For the Revision III - 360° Monitoring Program (ESE, 1986c, RIC#87016R05), one well was completed in the Denver aquifer. The sample from this well contained low levels of DIMP during the first quarter sampling. There were no detectable levels of DIMP from second quarter sampling. This well is paired with an alluvial aquifer well. Chloroform was detected at a low concentration level in a first quarter sample, while DIMP was detected during both sampling quarters at concentrations less than 10.5 ug/l. Water level measurements in these two wells indicate a lower potentiometric head in the Denver well implying a net downward gradient between the alluvial and Denver Fm aquifers in this area. Onpost water level data indicate a downward gradient between the two aquifers, the magnitude of which decreases in a northerly direction.

1.4.3 SURFACE WATER QUALITY

The complex interaction between surface water and ground water has a major impact on surface water quality. Ground-water discharge to surface water bodies is probably a major migration pathway in the study area. The purpose of the surface water sampling program was to monitor the flow rate and water quality of surface water as it enters and leaves the study area. From the limited number of points sampled, it is difficult to present more than a general overview of surface water quality across the study area. There are

three surface sites that can be used to describe surface water quality as it enters the RMA offpost study area. These three sites are:

- o South Platte upstream, Station 01CDD;
- o Burlington Ditch upstream, Station 01DCC; and
- o First Creek as it enters RMA, Station 08ADD.

These three sample stations are on the southern and southeastern boundaries of the study area as shown in Figure 1.4-3. All of the constituents detected at these three sampling stations are naturally occurring. Concentrations of chloride were below 250,000 ug/l. Fluoride concentrations were not detected above the 1,200 ug/l detection limit. Arsenic was detected in concentrations exceeding the 3.9 ug/l detection limit in the sample from First Creek as it enters the arsenal. Cadmium, chromium, copper, lead, and mercury were not detected in these samples.

Taking into account the possible variations in dilutions from one sampling quarter to the next, analyte values appear to be higher to the north of RMA's north boundary where several organic contaminants were detected in samples from both quarters. For the first quarter sampling, DIMP, aldrin, endrin, and chloroform were detected. During the second quarter sampling, DIMP and dieldrin were found in concentrations exceeding the respective detection limits. Data from subsequent sampling quarters are required to determine if there are any temporal trends associated with this organic contamination. The naturally occurring inorganic constituents, chloride and fluoride, were detected at concentrations exceeding drinking water quality standards during both quarters in Second Creek surface samples (07AAB).

DIMP is the primary organic contaminant detected in the offpost surface water. DIMP was detected in significant quantities, during both sampling quarters, in a First Creek sample (14BDD) immediately before it flows into the O'Brian Canal. A short distance upstream on First Creek (13DCC), DIMP values were much lower during both sampling quarters. The increase in DIMP concentrations over this short stretch of First Creek, just north of RMA, may indicate that the water table aquifer is contributing flow as well as organic contaminants to First Creek flow. This contention is supported by

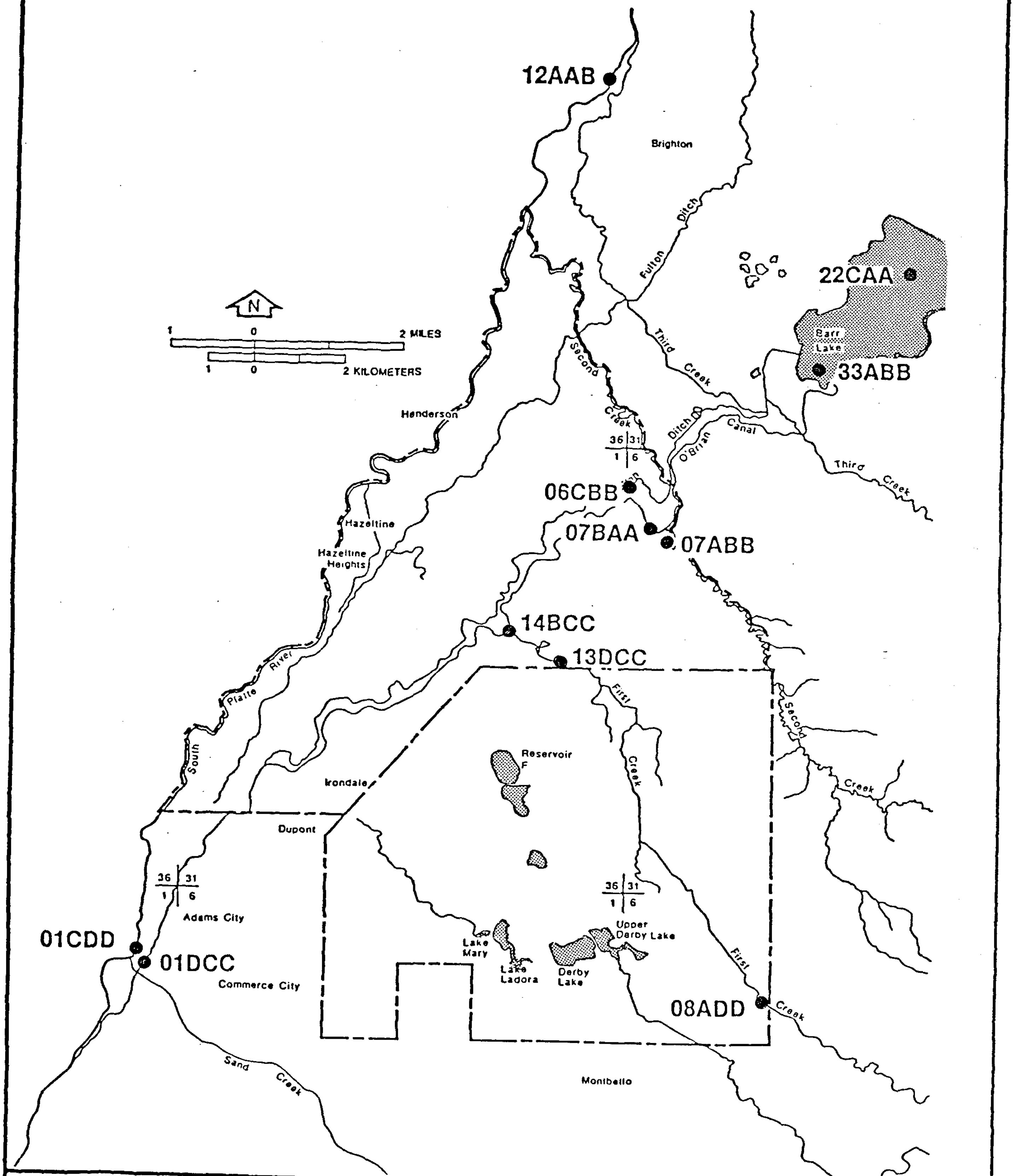

Figure 1.4-3
LOCATIONS FOR SURFACE WATER SAMPLING
OFFPOST CONTAMINATION ASSESSMENT
REVISION III-360° MONITORING PROGRAM
SOURCE: ESE, 1987

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stream flow gaging data for First Creek, which indicate an increase in flow between these two points. In addition, it should be noted that the marshy ground surface along this section of First Creek is indicative of a shallow water table in this area.

There were two unexpected detections of DIMP in the first quarter samples. These samples were taken from locations upgradient of RMA. The concentration values for DIMP in the South Platte River sample (01CDD) as it enters the study area was 13 ug/l with a detection limit of 10 ug/l. DIMP was detected in a sample from First Creek where it enters RMA. This DIMP concentration was 11 ug/l with a detection limit of 10 ug/l. There are several possible explanations for these upgradient detections of DIMP. Cross-contamination of surface water samples is unlikely because these are grab samples collected directly in the sample containers, and common equipment is not used repeatedly between sites. Analytical interferences during single column gas chromatograph (GC) analysis, especially in complex organic matrices, may be a potential problem when evaluating concentrations near the detection limit. Second column GC confirmation, or analysis by GC/mass spectrometry (GC/MS) can be used to confirm suspected analytical interferences. Repeated sampling and determination by several analytical methods will clarify the DIMP distribution of offpost surface waters.

A large part of the surface water drainage system for the offpost area flows into Barr Lake. The drainage system includes the Burlington Ditch and O'Brian Canal, along with the flows contributed to these irrigation canals by First and Second Creeks. During the first quarter sampling, chloroform and endrin were detected, however, no organic contaminants were detected in Barr Lake during the second quarter. These discrepancies may be due to seasonal changes in flow to the lake. Additional data are required to delineate these trends.

The stream and lake sediments of the offpost study area tend to effectively remove metals from their respective water columns. Metals may be removed from the water column by a number of geochemical mechanisms and concentrated in sediments. These mechanisms may include adsorption by clay minerals,

precipitation, or co-precipitation with iron and manganese oxyhydroxides. There is a good relationship in offpost samples between the grain size of the sediments, as evidenced by the percentage of moisture in the wet samples, and the amount of heavy metals adsorbed. The Barr Lake sample, which consisted of a dark, organic rich clay, contained much higher levels of zinc, lead, copper, chromium, and mercury than the other samples. From the limited data available, it appears that the Barr Lake sediments are acting as a metals "sink" for the surface drainage system.

1.5 GENERAL APPROACH

The first part of the offpost RI/FS are investigative activities which will focus on all contaminants that have been identified on RMA (Spain et al., 1984, RIC#85133R04) and will evaluate the extent to which they may have migrated offpost. The RI will supplement data already available from the offpost CAR to better define offpost ground-water flow patterns, determine the present level and distribution of contaminants, and predict future contamination migration trends. This portion of the study will emphasize offpost areas identified in the CAR as being zones of higher contamination directly related to RMA. Rationale for the specifics of the RI Program is addressed in Section 2.0, the Geotechnical Program.

Concurrent with the RI, a preliminary assessment of exposure to offpost RMA contaminants to humans will be conducted. The assessment will first determine if there is a population exposed to contaminants and, if so, at what concentrations. Interim response actions will be proposed if appropriate.

The second major part of Task 39 is an EA which will be performed for the offpost areas designated for this study. The overall objective of the EA is to provide a determination of the magnitude and probability of actual or potential harm to the public or to the environment from ground and surface water pollutants migrating from RMA to areas north and northwest of RMA as defined by the study area. Based upon the risk identified in the EA, the need for long-term remedial actions will be identified.

A major portion of Task 39 will be the performance of a FS. This study will evaluate long-term remedial actions that could eliminate any unacceptable risks to the public or environment identified in the EA. The final product of the evauation will be a recommendation for a specific remedial action that is considered most feasible for mitigating unacceptable risks posed by offpost contamination. After an appropriate public comment period, a ROD will be issued that selects the remedial action or explains why the no-action alternative is appropriate.

1.6 ORGANIZATION OF THE TECHNICAL AND MANAGEMENT PLANS

Section 2.0 of this plan describes the specific geotechnical program required to better define the ground water flow and patterns of contamination in the areas north and northwest of RMA. Section 3.0 describes the sampling procedure for ground water, shipping, and chain-of-custody requirements. The chemical analysis procedures and method certification are addressed in Sections 4.0 and 5.0, respectively. Section 6.0 details the safety plan that will be used for field activities necessary to complete the remedial investigation. Section 7.0 describes the data management program necessary to assimilate new data along with existing data to develop a clear picture of the offpost ground-water and surface water contamination. Section 8.0 details the methodology that will be used to evaluate existing and new data and determine the extent of offpost ground-water contamination. Section 9.0 describes the EA methodology which will be required to determine the magnitude and probability of actual or potential harm to the public or the environment. Section 10.0 outlines the procedures needed to evaluate and recommend long-term remedial actions to mitigate unacceptable effects from the offpost contamination to the north and northwest of RMA.

Management support for technical activities described in this Technical Plan is described under a separate cover in the Management Plan. The Management Plan describes the following:

- Project Organization and Management Procedures;
- Data Management Plan;

- Safety Plan; and
- Reporting and Administration Requirements.

These management elements describe the procedures to control the technical activities; ensure accurate, timely transmission of data and reports required in the survey; and provide the operational procedures required to ensure that all activities are conducted in a safe manner. The Management Plan will be used to assure cost-effective completion of Task 39.

PART II - REMEDIAL INVESTIGATION
(SECTIONS 2.0 - 8.0)

2.0 GEOTECHNICAL PROGRAM

2.1 MONITOR WELL AND BOREHOLE NETWORK RATIONALE

The proposed monitor well and borehole drilling program for the offpost area is a comprehensive plan which involves elements of the boundary systems evaluations in Tasks 25 and 36 as well as the activities proposed in Task 39. This program has been developed to supplement data from the Offpost CAR and to more specifically define the extent and level of contamination that has migrated downgradient from the RMA boundary. The placement of the well and borehole network has been designed to meet the following objectives:

- Further definition of offpost geology;
- More specific delineation of known contaminated alluvial ground-water concentrations and plume boundaries;
- Delineation of suspected offpost contaminated alluvial ground-water concentration and plume boundaries;
- Characterization of Denver Fm ground-water quality in contaminated areas near the RMA boundary;
- Characterization of the extent and quality of discharge from Denver Fm sandstone units and the alluvium in areas downgradient of the RMA northern boundary;
- Characterization of ground-water quality in population centers and other locations of ground water used by human, food chain crops, and livestock;
- Description of the aquifer systems affecting contaminant transport; and
- Definition of aquifer characteristics necessary for input into ground-water models and to evaluate remedial action alternatives.

2.1.1 SITING RATIONALE

Twenty-three potential well and/or borehole sites have been proposed under this task. The approximate locations of well and/or borehole sites are shown in Figure 2.1-1. The precise location of sites will depend on obtaining rights of entry, access ways, rights-of-way, and evaluation of ongoing monitoring results. Revised locations of existing sites and new locations for additional sites will be defined in Letter Technical Plans as

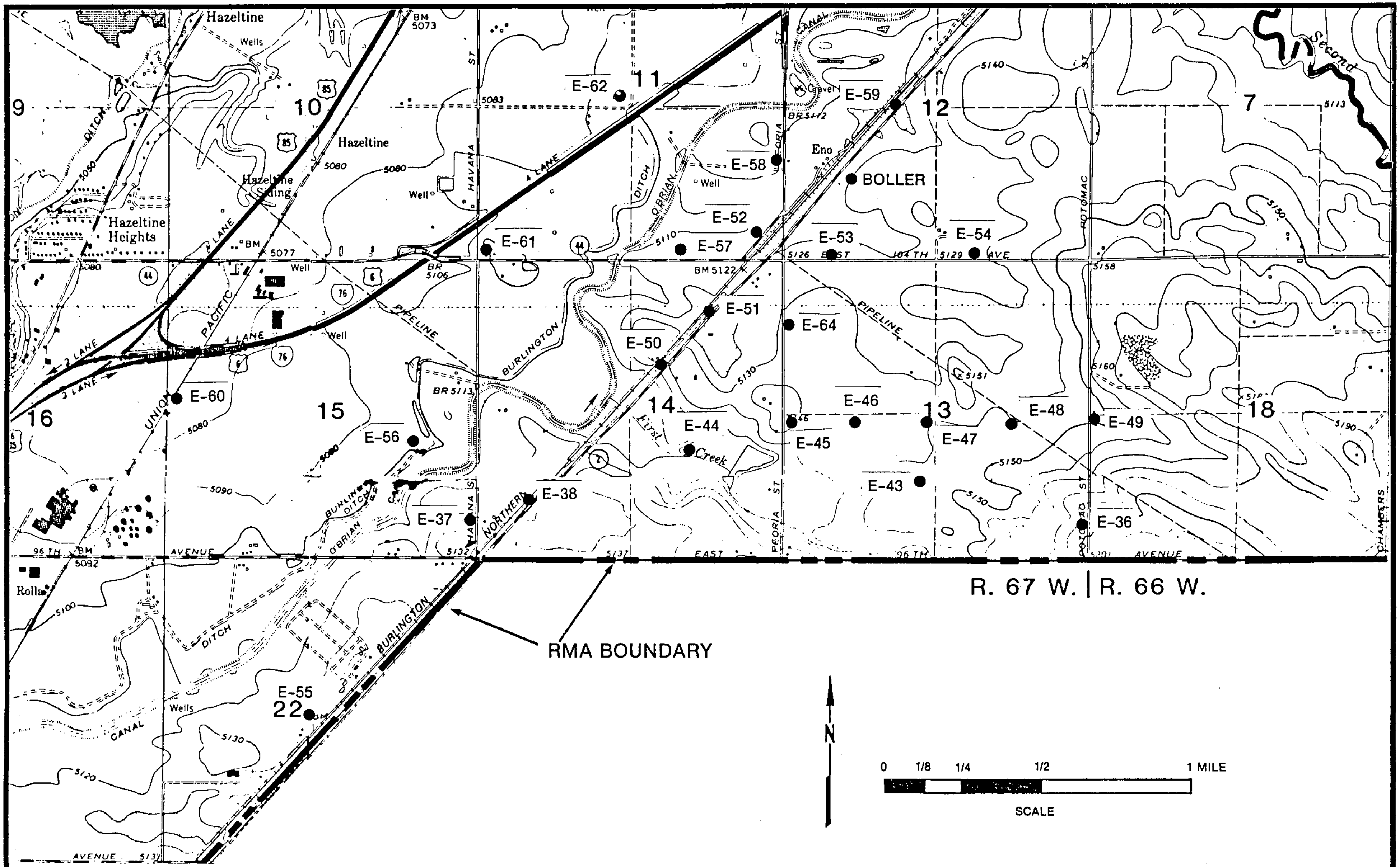

Figure 2.1-1
PROPOSED MONITOR AND BOREHOLE LOCATIONS
FOR TASK 39

SOURCE: ESE, 1988

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Aberdeen Proving Ground, Maryland

the program develops, and will be incorporated in Appendix B of this Technical Plan. The number of wells proposed per site and the completion interval for each well are specified in Section 2.1.2. There are two primary objectives of this monitoring program. The first is to delineate suspected contaminated alluvial ground-water plumes that may be emanating from the RMA northern boundary. This will include further definition of the known contaminant plume extending northwestward from the northern boundary along the inferred First Creek paleochannel described in the Offpost CAR (ESE, 1987, RIC#87202R01). It will also include determining whether contaminant plumes extend from the RMA northern boundary to remote areas to the north of RMA where isolated detections of several RMA-specific contaminants have been documented. Any plumes that are defined in this area will be specifically delineated in enough detail to evaluate remedial action alternatives.

The second major objective of the proposed monitoring plan is to assess the quality of ground water in Denver Fm aquifers downgradient of the RMA northern boundary. Of particular concern is whether these units are acting as contaminant migration pathways which bypass the North Boundary Treatment System (NBTS). The data from these wells will also be used to assess to what extent, if any, ground water from the Denver Fm may be contributing to alluvial aquifer contamination. This scenario is being addressed here because many of the Denver Fm units subcrop into the alluvium immediately downgradient of the RMA northern boundary. However, most of the Denver Fm wells will be installed under Task 36, the North Boundary System Component Remedial Action Assessment.

To accomplish these objectives, monitoring wells will be completed in both the alluvium and the sandstones of the Denver Fm as specified in Section 2.1.2. Rationale for siting are contained in Section 2.1.2 as well as in follow-up letter Technical Plans to be added in Appendix B. Cluster well sites will consist of one alluvial well paired with one or two Denver Fm wells. At sites with two Denver wells, the wells will be completed within the first and second sandstone aquifers encountered during drilling.

The installation of Denver Fm monitoring wells will be concentrated within an area immediately north of RMA and between Potomac Street and Colorado Route 2. The Denver wells are concentrated in this area to assess the ground-water quality in Denver sandstones which subcrop in this offpost area.

The network of wells and boreholes will be installed according to the priority denoted in Table 2.1-1. Sites denoting "high priority" are those deemed essential to achieve the objectives established for the program and those where data must be collected prior to drilling at other sites. These sites are essential for defining contaminant pathways in the alluvium from RMA to locations of isolated detection downgradient of RMA. These sites will be installed first.

Based upon the results of geologic, hydrologic, and chemical analyses from the "high priority" wells and boreholes, additional sites from the "moderate priority" category will be drilled. These sites are of lower priority and wells will be installed to provide specific data identified as being needed based on the initial group of sites. With the exception of Denver Wells E37 and E38, these sites will be utilized to further delineate the extent of alluvial contamination and delineate specific alluvial pathways. Likewise, sites denoted "low priority" will be installed based on requirements defined from the installation of the "moderate priority" wells.

The short time frame under which the task is being conducted and the general sparseness of existing data, necessitates that all potential sites be selected and permitted early in the program. The selection of these potential sites at an early date will ensure that additional sites can be developed in a timely manner if needed. It is probable that not all of the selected sites will be required to accomplish the objectives of the outlined program. However, the flexibility in choosing sites as the program evolves is essential to provide the geologic, hydrologic, and chemical data required for a comprehensive FS.

Table 2.1-1. Priority of Drill Sites

Priority	Drill Site Designation	Type Installation
High	E-44	Cluster
	E-46/47	Cluster
	E-50	Cluster
	E-53	Cluster
	E-55	Alluvial
	E-58	Alluvial
Moderate	E-37/38	Cluster
	E-43	Borehole
	E-45/64	Cluster
	E-48	Borehole
	E-52	Cluster
Low	E-36	Cluster
	E-49	Denver
	E-51	Cluster
	E-54	Cluster
	E-56	Alluvial
	E-57	Alluvial
	E-59	Alluvial
	E-60	Alluvial
	E-61	Alluvial
	E-62	Alluvial

Source: ESE, 1987.

2.1.2 DRILL SITE DESCRIPTION

Each site is described below, as well as the rationale for selection of the site. Sites containing high priority wells or boreholes are grouped together and are followed by sites with moderate and low priority wells and boreholes. Table 2.1-2 summarizes the land ownership of the proposed drill sites.

HIGH PRIORITY SITES

Proposed Site E-44--Site E-44 is located on property denoted by tax record number 1721-14-0-00-027 in the northwest quarter of the southeast quarter of Section 14 approximately 1,600 ft west of the east line and 1,900 ft north of the south line. This property is owned by:

Charles Hickey and Michael Hickey
3240 Jay Street
Wheatridge, Colorado 80033
(303) 233-9003.

Access to this site is on a 40-ft wide easement along the drainage of First Creek, southeast from Highway 2, or along any other suitable corridor as suggested by the property owner. Access is needed to drill a test boring in a suitable site at or very near the proposed site, and to install and complete a cluster on the alluvial well and one or two Denver wells. The total area of permanent disturbance will be a 20-ft by 20-ft area around the well cluster. In addition, future access to the monitor well site for periodic sampling will be needed. The alluvial well is a high priority site to assess the concentration and extent of contaminants along First Creek. The Denver wells are lower priority because their installation is dependent on whether contamination of the Denver is found closer to the RMA north boundary.

Table 2.1-2. Land Ownership at Proposed Drill Sites

Well Number	Ownership of Right-of-Way
<u>High Priority</u>	
E-44	Private Owner
E-46	Private Owner
E-47	Private Owner
E-50	State Highway Department
E-53	Adams County Highway Department
E-55	Adams County Highway Department
E-58	Adams County Highway Department
<u>Moderate Priority</u>	
E-37	Adams County Highway Department
E-38	State Highway Department
E-43	Private Owner
E-45	Adams County Highway Department
E-64	Adams County Highway Department
E-48	Private Owner
E-52	Adams County Highway Department
<u>Low Priority</u>	
E-36	Adams County Highway Department
E-49	Adams County Highway Department
E-51	State Highway Department
E-54	Adams County Highway Department
E-56	Private Owner
E-57	State Highway Department
E-59	State Highway Department
E-60	Union Pacific Railroad
E-61	Adams County Highway Department
E-62	Private Owner

Proposed Site E-46--E-46 is a site located on property denoted by tax record 1721-00-0-00-030 in the southwest quarter of Section 13 and is owned by:

Adams County Joint Venture
% Butler and Pierce
720 Kipling Street, Suite 201
Lakewood, Colorado 80215
(303) 232-3888.

A 50-ft easement and corridor of access is needed along the northern, eastern, and southwestern property lines to drill several borings and to install monitoring wells. Site E-46 is a proposed well location. There will be one alluvial and two Denver wells installed at the well site. Continued access along the north and southwest corridors for periodic monitoring every three months will be required. Site E-47 may be developed in lieu of this site. The alluvial well is high priority because it is needed to define a suspected bedrock paleochannel and determine the concentration and extent of contamination. The Denver wells are lower priority and installation is dependent on whether specific Denver units are contaminated upgradient.

Proposed Site E-47--E-47 is a site located on property denoted by tax record 1721-00-0-00-030 in the southeast quarter of Section 13 and is owned by:

Adams County Joint Venture
% Butler and Pierce
720 Kipling Street, Suite 201
Lakewood, Colorado 80215.
(303) 232-3888

A 50-ft easement and corridor of access is needed along the northern, eastern, and southwestern property lines to drill several borings and install monitoring wells. There will be one alluvial and two Denver wells installed at the well site. Continued access along the north and southwest corridors for periodic monitoring will be required. This site may be developed in lieu of Site E-46. The alluvial well is high priority because it is needed to help define a suspected bedrock paleochannel and determine

the concentration and extent of contamination. The Denver wells are lower priority and installation is dependent on whether specific Denver units are contaminated upgradient.

Proposed Site E-50--E-50 is a site for the installation of one alluvial well and one optional Denver well along the west side of Highway 2. It is 3,100 ft east of the west line and 3,500 ft north of the south line of Section 14 and lies in the southwest quarter of the northeast quarter of Section 14. This is a moderate priority alluvial site to assess the concentration and extent of contaminants along the First Creek paleochannel. Denver wells at this site are lower priority because they will depend upon findings upgradient.

Proposed Site E-53--Site E-53 is along the north side of East 104th Avenue approximately 900 ft east of the west line and 20 ft north of the south line in the southwest quarter of the southwest quarter of Section 12. This site is for the installation of one high priority alluvial well and two low priority Denver wells. The alluvial well will be used to assess the water quality and alluvial geology upgradient of the Boller well. Installation of Denver wells will depend on the findings from Denver wells upgradient.

Proposed Site E-55--Site E-55 is located approximately 2,600 ft from the south line and 1,600 ft from the west line of Section 22. This site is proposed in order to provide additional monitoring downgradient from the NBCS.

Proposed Site E-58--Site E-58 is along Peoria Street on the west side about 1,700 ft north of the south line and 20 ft west of the east line in the northeast quarter of the southeast quarter of Section 11. This site is for the installation of one alluvial well. This is a high priority site which will be used to assess water quality downgradient of the Boller well.

MODERATE PRIORITY

Proposed Site E-37--Site E-37 is along the west side of Havana Street, 800 ft north of the south line and approximately 20 ft west of the east line

of Section 15 and is in the southeast quarter of the southeast quarter of Section 15. This site is for a possible cluster, one alluvial and two Denver wells. Site E-38 may be developed in lieu of this site.

Proposed Site E-38--E-38 is a site for the installation of a possible cluster of one alluvial and two Denver wells along the west side of Highway 2, approximately 1,200 ft northeast of the intersection of East 96th Avenue. The site is 900 ft east of the west section line and 900 ft north of the south section line lying in the southwest quarter of the southwest quarter of Section 14. Site E-37 may be developed in lieu of this site. This site may be necessary to determine the extent of alluvial contamination along the inferred First Creek paleochannel and the possibility of Denver contamination just northwest of the RMA north boundary.

Proposed Site E-43--E-43 is a site located on property donated by tax record 1721-00-0-00-030 in the southwest quarter of Section 13 and is owned by:

Adams County Joint Venture
% Butler and Pierce
720 Kipling Street, Suite 201
Lakewood, Colorado 80215
(303) 232-3888.

A 50-ft easement and corridor of access is required along the northern, eastern, and southwestern property lines of the property to drill a boring. This site may be necessary to define the geology north of the eastern portion of the NBTS.

Proposed Site E-45--Site E-45 is along the east side of Peoria Street about 20 ft east of the west line and 2,700 ft north of the south line of Section 13 lying in the northwest quarter of the southwest quarter of Section 13. This site is for a cluster of two Denver wells at the site of the existing alluvial Well 37323. Site E-64 may be developed in lieu of this site.

Proposed Site E-64--Site E-64 is along the east side of Peoria Street approximately 4,000 ft north of the south line and 20 ft east of the west

line of Section 13. The site lies in the northwest quarter of the northwest quarter of Section 13. This site is for the installation of one to three wells. Site E-45 may be developed in lieu of this site. This is a moderate priority alluvial site to determine geology and water quality. Denver wells are lower priority and will be dependent on upgradient wells.

Proposed Site E-48--Site E-48 is located on property denoted by property tax record number 1721-00-0-00-007 in the center of the east half of Section 13 on property owned by:

Box Elder Farms Company
1125 17th Street, Suite 2500
Denver, Colorado 80202
(303) 371-5026.

A 50-ft easement is needed for temporary access along a corridor from the center point of Section 13 due eastward to the east section line (Potomac Street) for the purpose of drilling one or more borings. It is planned at this time to drill the proposed boring(s) and then abandon the site following approved borehole abandonment and reclamation procedures. No further access is expected after the boring(s) are completed. This site is needed to assess the geology at the very eastern extreme of a suspected bedrock paleochannel.

Proposed Site E-52--Site E-52 is along the northwest side of Peoria Street approximately 500 ft northeast of the intersection with East 104 Avenue. This site is in the southeast quarter of the southeast quarter of Section 11, approximately 400 ft west of the east line and 400 ft north of the south section line. This site will be used for the installation of one alluvial well. This well is a moderate priority and its installation will depend on water quality in nearby high priority alluvial wells.

LOW PRIORITY

Proposed Site E-36--Site E-36 is along the west side of Potomac Street approximately 20 ft west of the east line and 500 ft north of the south line in the southeast quarter of the southeast quarter of Section 13. This site

is for a possible cluster of one alluvial and two Denver wells. E-36 is a low priority site for assessing both the extent of alluvial contamination downgradient of the RMA north boundary and possible Denver Fm contamination.

Proposed Site E-49--Site E-49 lies along the east side of Potomac Street about 2,600 ft north of the south line and 20 ft east of the west line in the northwest quarter of the southwest quarter of Section 18. This site is for the installation of two Denver wells at the site of existing alluvial Well 37327. This site is a low priority site to assess possible Denver Fm contamination.

Proposed Site E-51--E-51 is at the site of an existing shallow well 37342 where an additional one or two optional Denver wells will be installed. The site is approximately 3,800 ft east of the west line and 4,300 ft north of the south line in the northwest quarter of the northeast quarter of Section 14. All wells at this site are low priority because of high priority sites nearby.

Proposed Site E-54--Site E-54 is along the north side of East 104th Avenue approximately 3,300 ft east of the west line and 20 ft north of the south line the southwest quarter of the southeast quarter of Section 12. This site is for the installation of one alluvial well and two optional Denver wells. This is a lower priority site and will depend on findings at E-53 and upgradient Denver wells.

Proposed Site E-56--Site E-56 is located on land denoted by property tax record number 17231-15-0-00-020 in the northeast quarter of the southeast quarter of Section 15, approximately 1,000 ft west of the east line and 2,000 ft north of the south line. This property is owned by:

Mollie Heinze
% Dave Heinze
10131 E. 96th Avenue
Henderson, Colorado 80640
(303) 268-1600.

The site is just northwest of the Burlington Ditch and access is anticipated to be by the "ditch rider road" along the ditch northeastward from East 96th Avenue. A 40-ft corridor of access and easement is needed to drill a test bore, and install and complete one alluvial monitoring well at the proposed site. Total permanent disturbance will be a 5-ft by 5-ft area around the well. Future access will be needed for periodic sampling. This is a low priority well which could be installed to assess downgradient water quality based on water quality from upgradient sites.

Proposed Site E-57--Site E-57 is along the north side of Highway 44 (East 104th Avenue west of the junction with Highway 2) which runs along the south line of Section 11. The site is about 3,500 ft east of the west line and 30 ft north of the south line lying in the southwest quarter of the southeast quarter of Section 11. This site is for the installation of one optional alluvial well. This is a low priority well which could be installed to assess downgradient water quality based on water quality from upgradient sites.

Proposed Site E-59--Site E-59 lies along the northwest side Highway 2, approximately 1,900 ft east of the west line and 2,800 ft north of the south line in the southeast quarter of the northwest quarter of Section 12. This installation is for one optional alluvial well. This is a low priority well which could be installed to assess downgradient water quality based on water quality from upgradient sites.

Proposed Site E-60--Site E-60 is located on property that is the right-of-way of the Union Pacific Railroad Company. Contact:

Union Pacific Railroad Company
Office of Director-Real Estate
Omaha, Nebraska.

The proposed site is 50 ft east of the west line and 2,600 ft north of the south line in the northwest quarter of the southwest quarter of Section 15.

A 50-ft easement and corridor of access is needed along the side of the railroad tracks to drill a test boring, and install a monitoring well in the alluvium at, or very near, the proposed site. The total permanent disturbance will be a 5-ft by 5-ft area around the well. This well will require future access along the railroads and an access road for periodic ground-water sampling. The well location will be a minimum of 50 ft east of the center line of the railroad tracks. This is a low priority well which could be installed to assess downgradient water quality based on water quality from upgradient sites.

Proposed Site E-61--Site E-61 is along the north side of Highway 44 approximately 100 ft east of the west line and 30 ft north of the south line in the southwest quarter of the southwest quarter of Section 11. This site is for the installation of one optional alluvial well. This is a low priority well which could be installed to assess downgradient water quality based on water quality from upgradient wells.

Proposed Site E-62--Site E-62 is located on property denoted by tax record number 1721-11-0-00-008 in the center of Section 11 approximately 2,600 ft south of the north line and 2,600 ft east of the west line of Section 11 on property owned by:

Glenn A. Murray Trust
11010 Havana Street
Route 3, Box 166A
Henderson, Colorado 80640
(303) 288-2998.

Access to the site is needed along either of the private roads that run along the east or south boundaries of the property. This will give access from either Havana Street or East 112th Avenue. The site is proposed to be adjacent to the Burlington Ditch. Activities at the site would include a test borehole, and completion and installation of an alluvial monitoring well. The total permanent disturbance will be an area around the well of 5 ft by 5 ft. Future access to the site is requested for periodic sampling. This site is optional. This is a low priority well which could be installed

to assess downgradient water quality based on water quality from upgradient sites.

The exact location of each monitoring well will depend on access, and the location of overhead and buried utility lines. The land ownership at proposed well locations is listed in Table 2.1-2. Highway right-of-way information was obtained from the State of Colorado Department of Highways and the Adams County Highways Department.

To assist in identifying any hazardous situations which may exist due to overhead power lines, telephone lines, etc., the following utilities and gas line companies will be contacted during installation of the monitoring wells.

- Union Rural Electric Association;
- Public Service Company of Colorado;
- Mountain Bell, Adams City Office;
- South Adams County Water and Sanitation District; and
- Public Utility Commission.

2.2 INITIATION OF FIELD PROGRAM

Drilling equipment, including drill rods, samplers, and tools will be steam cleaned prior to project site arrival. The procedures will be repeated between the drilling of each well. Only USATHAMA approved lubricants, such as petroleum jelly, will be used on the threads of downhole drilling equipment. Water to be used in drilling, grouting, or decontamination will be obtained from a PMO-RMA approved source. Downhole geophysical surveys will be consistent with those outlined in Section 3.0 of Task 1 Technical Plan (ESE, 1985a, RIC#85127R07) and (USATHAMA, 1983) geophysical requirements.

2.3 SAMPLING

Continuous alluvial soil samples will be collected using rotary or hollow stem auger sampling techniques. The continuous soil samples will be collected in polybutyrate tubes and transferred to a central logging

facility. The soil samples will be logged and then stored in the polybutyrate tubes or 1-pint wide-mouth jars.

Rotary core drilling methods will be used to collect a 2 1/2-inch diameter rock core. Hollow-stem augers or conductor casing will be advanced into bedrock, sealed with bentonite, and then rinsed with approved water to minimize alluvial contamination. The 2 1/2-inch rock core will be taken from a depth of at least 5 ft below the water bearing unit which is to be screened. The rock core will be logged in detail, photographed, wrapped in plastic, and then stored in cardboard coreboxes.

2.4 WELL DRILLING AND INSTALLATION

Installation of monitor wells will begin within 12 consecutive hours of borehole completion for uncased or partially cased holes and within 60 consecutive hours in fully cased holes. Once installation has begun, no break in the installation process will be made until the well has been grouted and the protective casing installed. All materials used in well construction will meet USATHAMA specifications and be approved by PMO-RMA prior to use.

2.4.1 ALLUVIAL WELLS

Alluvial wells will be drilled with 8 1/4-inch inside diameter (ID) hollow-stem augers following soil sample collection. The hollow-stem augers will be advanced into bedrock 1 to 2 ft. In general, wells will be screened from the bedrock contact to approximately 5 ft above the water table surface. Wells will be completed as shown in Figure 2.4-1. The details of the materials and methods to be used in well construction are described in Section 2.4.3 through Section 2.4.6.

2.4.2 BEDROCK WELLS

Pilot coreholes will be drilled first at all bedrock well sites. This will be achieved by drilling the alluvium, sealing the alluvium, sealing the alluvium from lower units by placing temporary conductor casing throughout the alluvium, and then coring the bedrock to at least 5 ft below the lowest water yielding unit to be monitored. This procedure will enable the

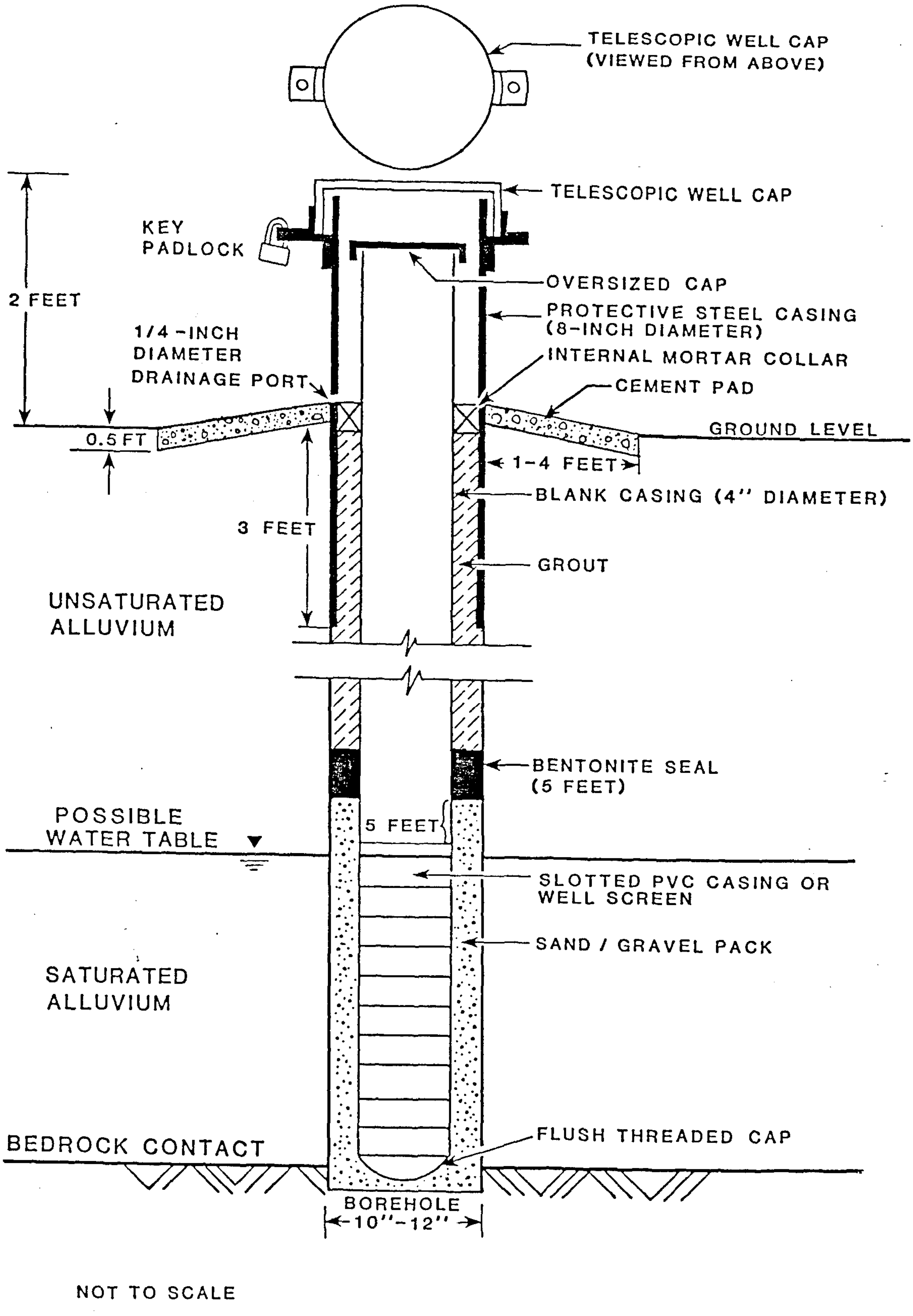


Figure 2.4-1 GENERALIZED SHALLOW (ALLUVIAL) MONITOR WELL CONSTRUCTION SOURCE: ESE, 1985	**Prepared for:** **U.S. Army Program Manager's Office** **For Rocky Mountain Arsenal** **Aberdeen Proving Ground, Maryland**

detailed lithology of the site to be obtained, planning of well construction, and procurement of necessary equipment.

In general, bedrock wells will be drilled using direct rotary methods. In instances where sloughing is a concern in the alluvium or there is no potential for contaminating a lower aquifer, the alluvium may be drilled with hollow-stem augers (Figures 2.4-2 through 2.4-4). When contamination of lower aquifers is possible, the borehole will be reamed and conductor casing will be grouted in place before drilling into the next water yielding unit. This procedure will be followed until the water yielding aquifer to be monitored is encountered. Well sites will be located approximately 20 ft from the pilot corehole.

Figures 2.4-2 through 2.4-8 describe different well installations which depend on hydrogeologic conditions and the specific water yielding unit to be screened. Figure 2.4-9 is a schematic drawing of a typical cluster well installation. The well head completions will be the same as shown for the alluvial well diagrams in Figure 2.4-1.

2.4.3 TELESCOPE CASINGS, WELL SCREENS, AND FITTINGS

Completion details are shown in Figure 2.4-1. Well screen will be commercially fabricated, high-flow, 20-slot (0.020 inch) PVC having an ID of 4 inches. The bottom of the screen will be fitted with a threaded PVC cap located within 6 inches of the screen. The screen will extend throughout the water bearing unit and will be attached to Schedule 40 PVC casing by a nonrestrictive threaded type joint. Alluvial wells will be screened 5 ft above the water table. Telescope casing used to prevent cross-contamination between aquifers will be standard black iron pipe.

Prior to installation, all screens and casing materials will be decontaminated and stored in plastic. They will be clean and free from foreign matter (adhesive tape, labels, soil, grease, etc.) and will be washed with approved water. Casing tops will be fitted with oversized, hand removable tops. Stainless steel well centralizers will be attached by stainless steel clamps and will be used only on blank casing and above the

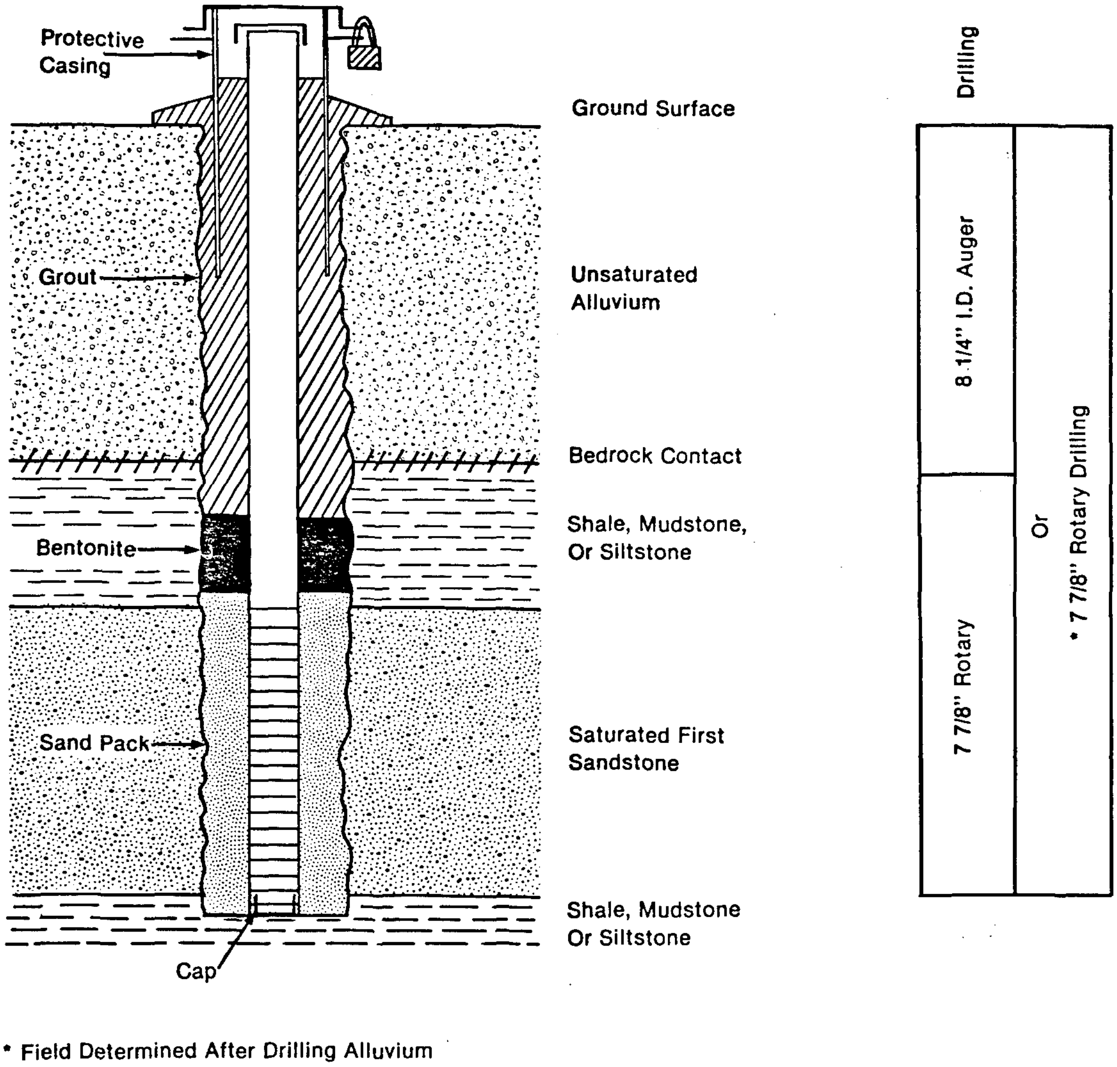
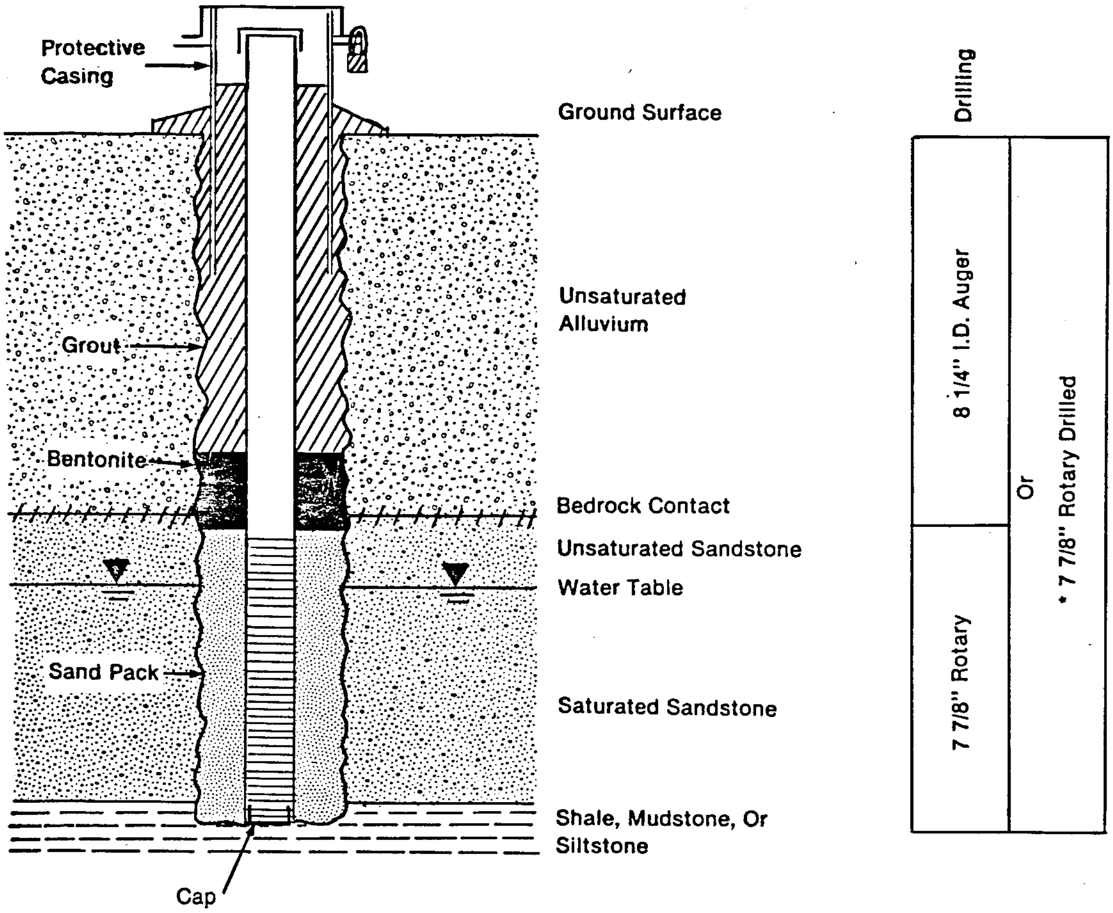


Figure 2.4-2
DENVER FM. WELL COMPLETE IN THE FIRST SANDSTONE, ALLUVIUM UNSATURATED, SHALE AT THE ALLUVIAL-BEDROCK CONTACT

SOURCE: ESE, 1986

Prepared for:
U.S. Army Program Manager's Office For Rocky Mountain Arsenal
Aberdeen Proving Ground, Maryland



* Field Determination After Drilling Alluvium

Figure 2.4-3
DENVER FM. WELL COMPLETED IN FIRST SANDSTONE, ALLUVIUM UNSATURATED, SANDSTONE AT THE ALLUVIAL-BEDROCK CONTACT, SANDSTONE PARTIALLY SATURATED

SOURCE: ESE, 1986

Prepared for:
U.S. Army Program Manager's Office For Rocky Mountain Arsenal
Aberdeen Proving Ground, Maryland

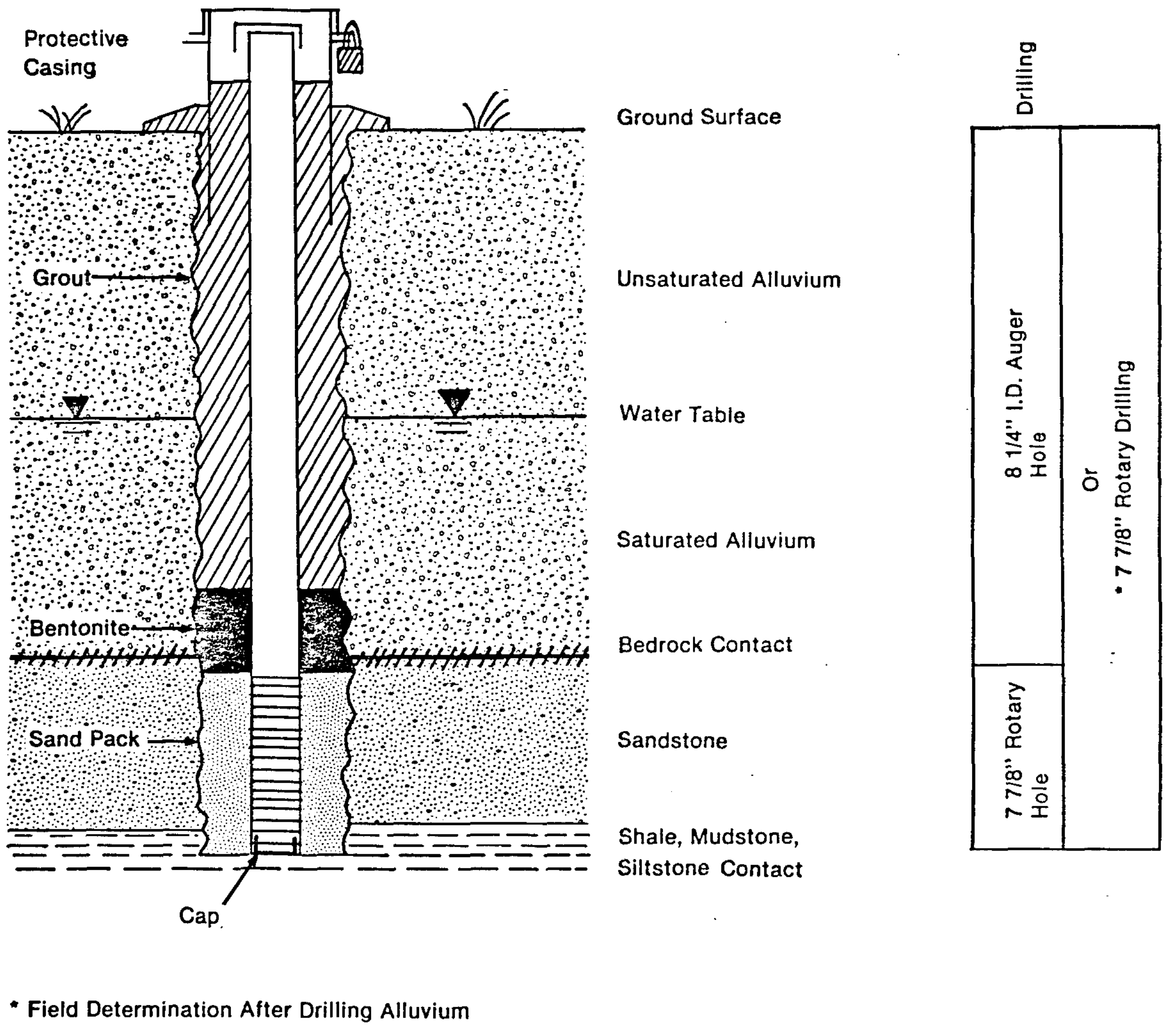
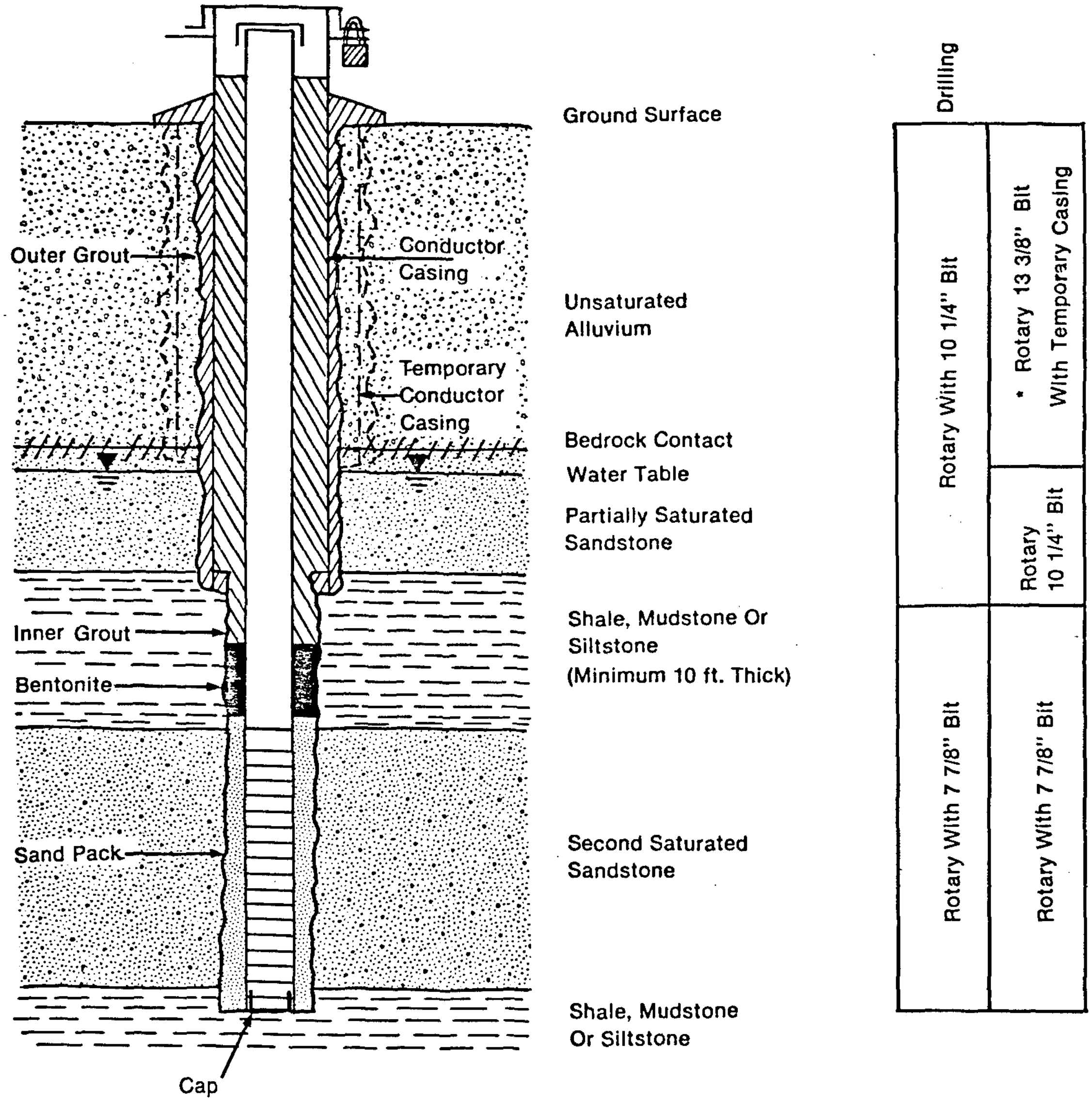


Figure 2.4-4
DENVER FM. WELL COMPLETED IN FIRST SANDSTONE, ALLUVIUM SATURATED, SANDSTONE AT THE ALLUVIAL-BEDROCK CONTACT

SOURCE: ESE, 1986

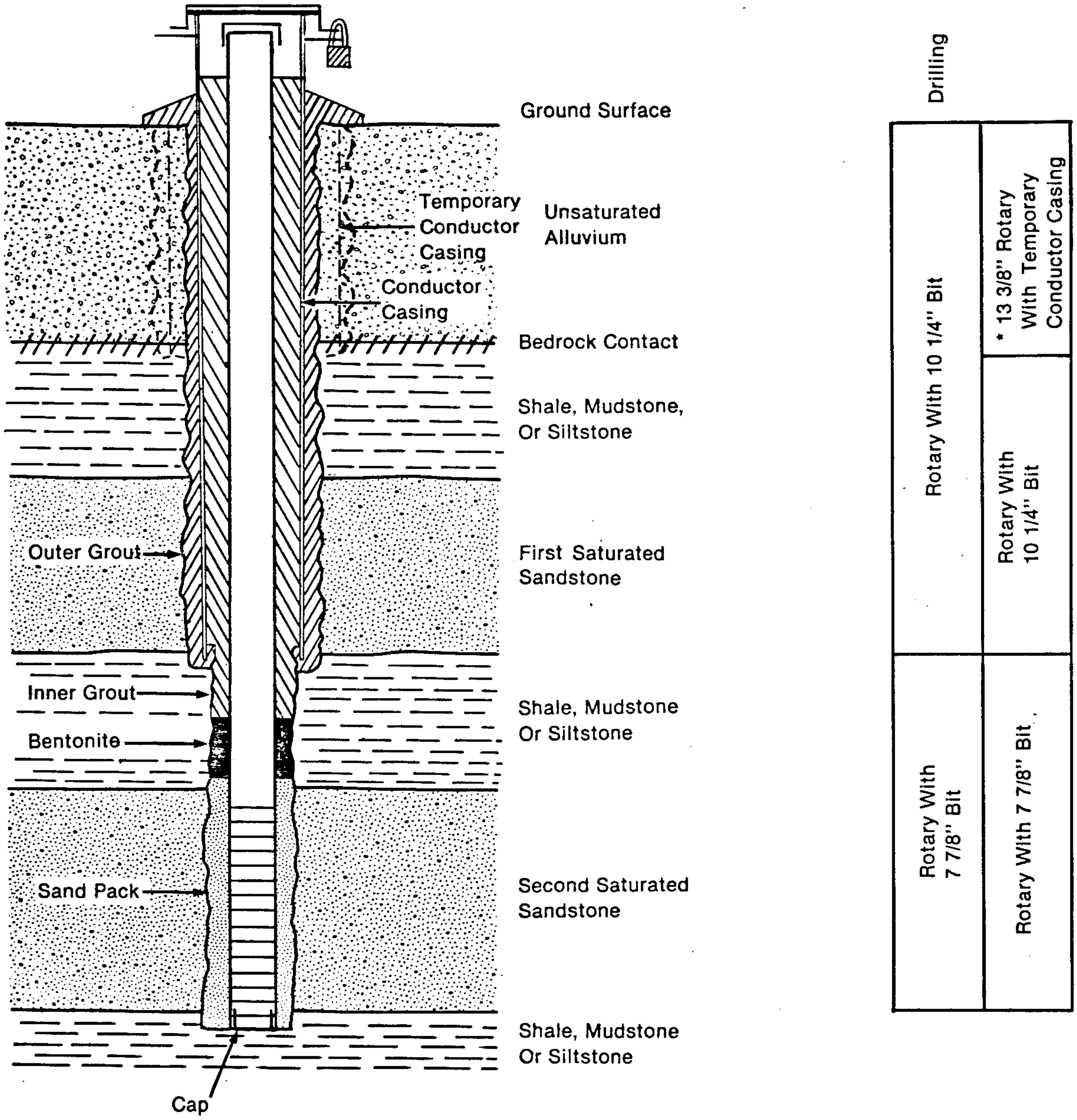
Prepared for:
U.S. Army Program Manager's Office For Rocky Mountain Arsenal
Aberdeen Proving Ground, Maryland



* Field Determination After Drilling Alluvium

Figure 2.4-5
DENVER FM. WELL COMPLETED IN THE SECOND SANDSTONE, ALLUVIUM UNSATURATED, SATURATED SANDSTONE AT THE ALLUVIAL-BEDROCK CONTACT
SOURCE: ESE, 1986

Prepared for:
U.S. Army Program Manager's Office For Rocky Mountain Arsenal
Aberdeen Proving Ground, Maryland



* Field Determination After Drilling Alluvium

Figure 2.4-6
DENVER FM. WELL COMPLETED IN THE SECOND SANDSTONE, ALLUVIUM UNSATURATED, SHALE AT THE ALLUVIAL-BEDROCK CONTACT, FIRST AND SECOND SANDSTONE SATURATED

Prepared for:
U.S. Army Program Manager's Office For Rocky Mountain Arsenal
Aberdeen Proving Ground, Maryland

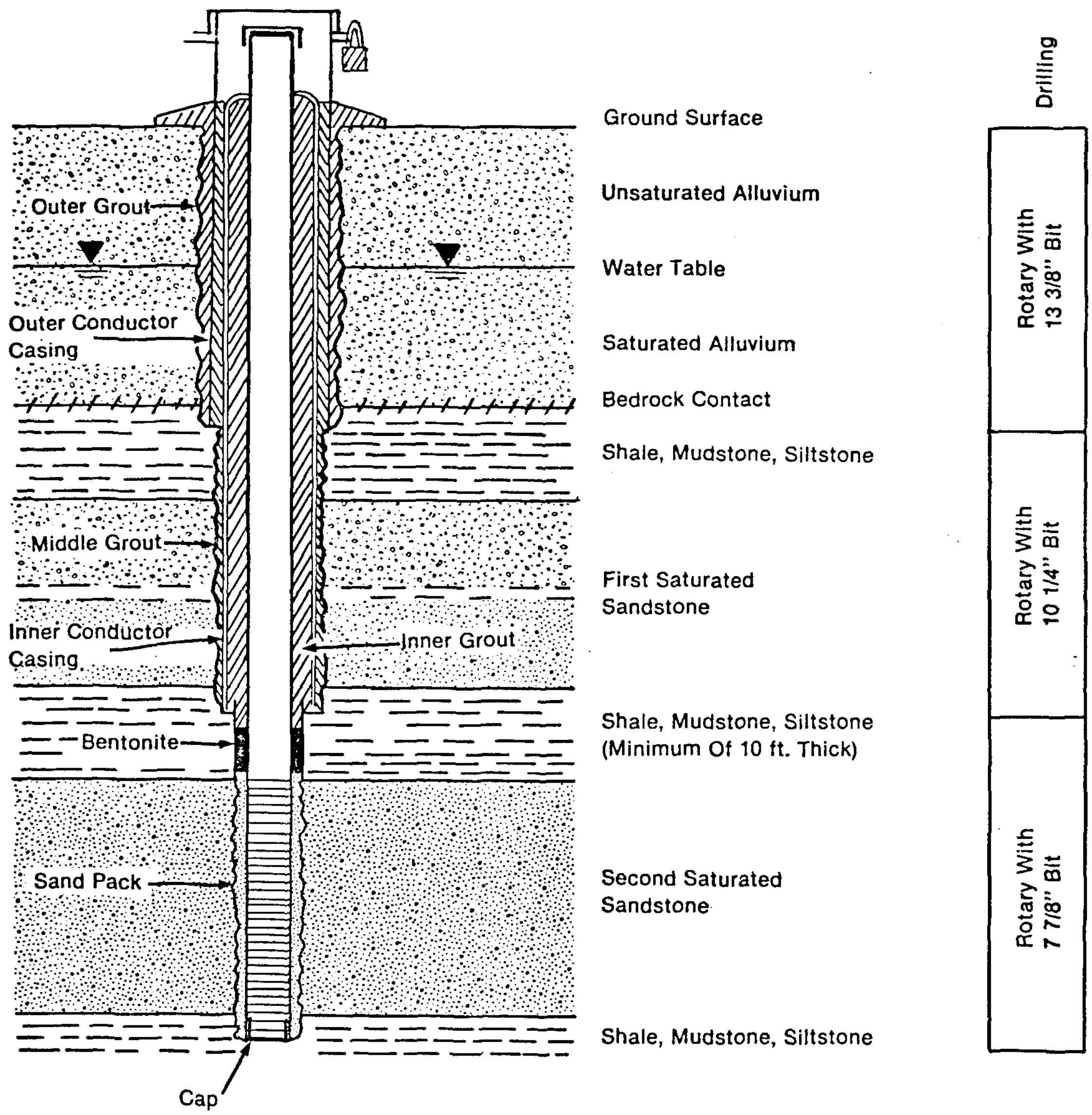


Figure 2.4-7
DENVER FM. WELL COMPLETED IN SECOND SANDSTONE, ALLUVIUM SATURATED, SHALE AT THE ALLUVIAL-BEDROCK CONTACT

SOURCE: ESE 1986

Prepared for:
U.S. Army Program Manager's Office For Rocky Mountain Arsenal
Aberdeen Proving Ground, Maryland

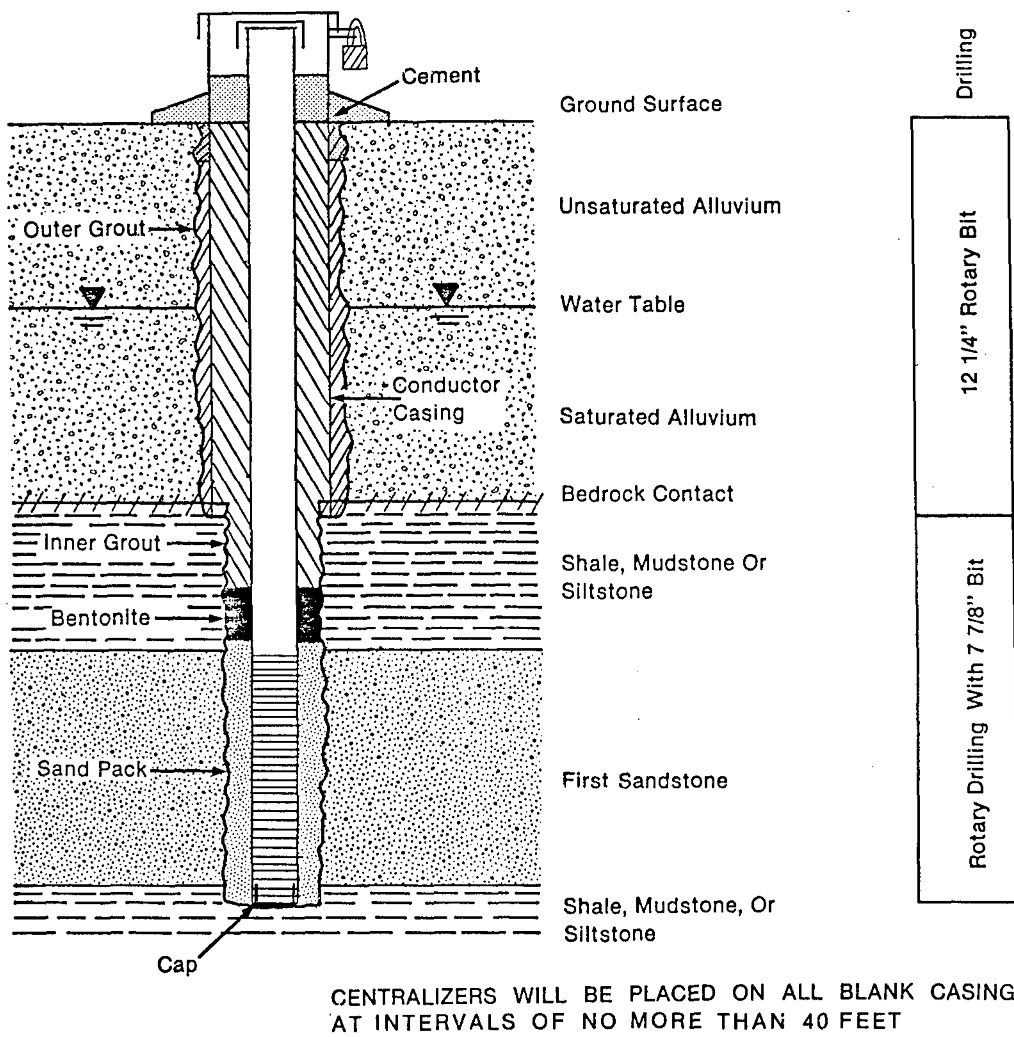


Figure2.4-8
GENERALIZED BEDROCK AQUIFER MONITOR WELL CONSTRUCTION (DENVER FM. WELL COMPLETED IN FIRST SANDSTONE, ALLUVIUM SATURATED, SHALE AT THE ALLUVIAL-BEDROCK CONTACT)

SOURCE: ESE,1986

Prepared for:
U.S. Army Program Manager's Office For Rocky Mountain Arsenal
Aberdeen Proving Ground, Maryland

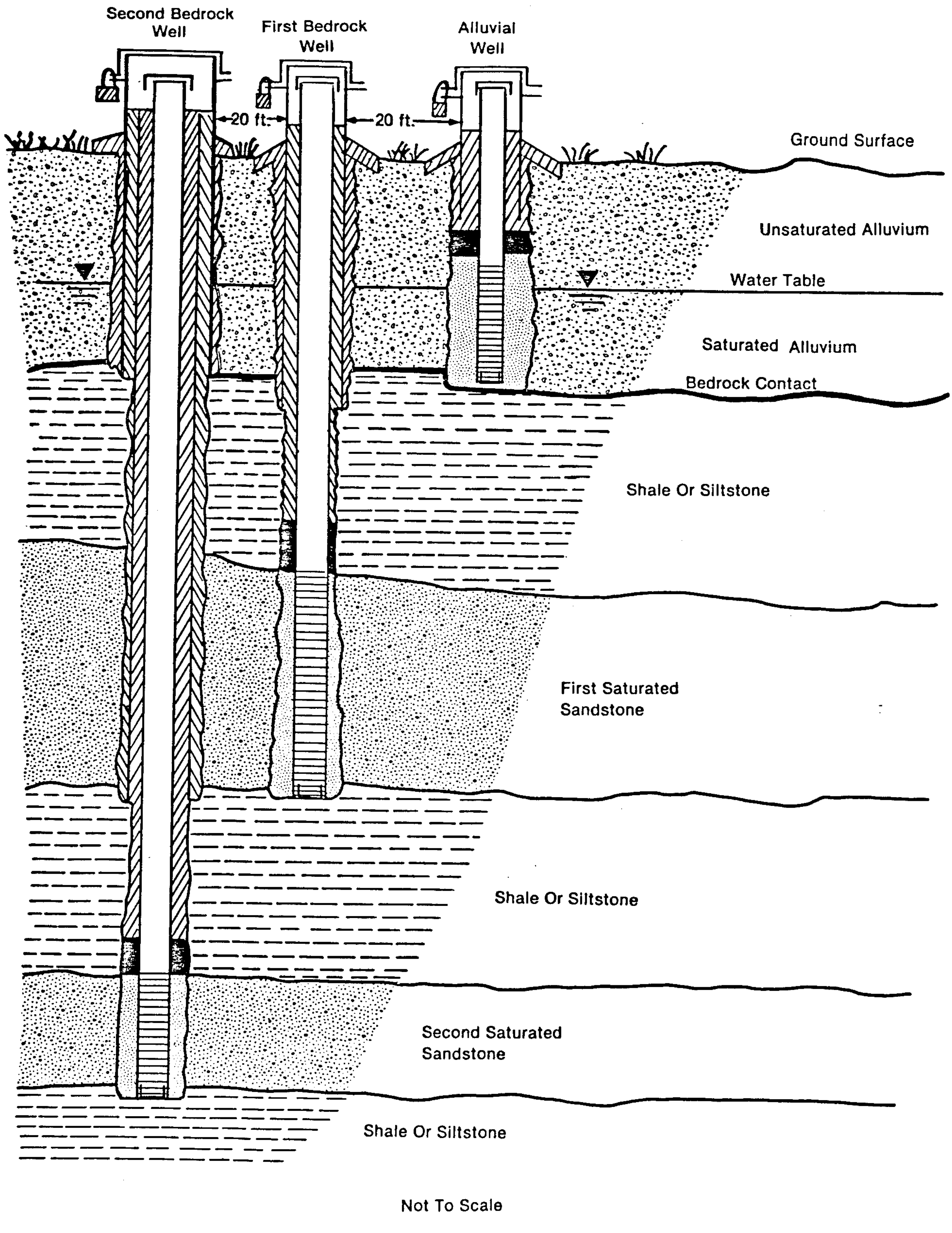


Figure 2.4-9
SCHEMATIC DRAWING OF A TYPICAL CLUSTER WELL INSTALLATION
SOURCE: ESE, 1986

Prepared for:
U.S. Army Program Manager's Office For Rocky Mountain Arsenal
Aberdeen Proving Ground, Maryland

sand pack. Boreholes containing excessively thick or particulate-laden fluid that might preclude or hinder well installation may be purged with PMO-RMA approved water.

2.4.4 SAND PACK

The annular space between the casing/screen assembly and the borehole will be filled with a sand pack to a depth of no less than 5 ft above the well screen if feasible. A 1-pint sample will be submitted to the PMO-RMA for approval prior to use on site. It is expected that the material used will be 8- to 12-mesh silica sand from Colorado Silica Sand, Inc. If water is needed to facilitate placement of the sand pack, a minimal amount of approved water will be used. The volume of this water will be recorded for subsequent removal during well development.

2.4.5 BENTONITE SEAL

A bentonite seal at least 5-ft thick will be placed above the sand pack except where shallow ground-water conditions prevent this. The thickness will be that measured immediately after placement, without allowance for swelling. The seal will be composed of commercially available bentonite pellets. This material will meet USATHAMA specifications and be approved by PMO-RMA prior to use on the site. Bentonite will be placed as shown in Figure 2.4-1 through 2.4-9.

2.4.6 GROUT SEAL

Annular spaces will be grouted by pumping through a tremie pipe placed at the bottom of the interval to be grouted or by gravity placement within hollow-stem augers. The grout will be composed of 20 parts cement to a minimum of 1 part bentonite with a maximum of 12 gallons of water per sack of cement for a pumpable mixture. These materials will meet USATHAMA specifications and be approved by PMO-RMA prior to use on site. The grout seal will be inspected for settlement 24 hours after placement and grout will be added, if necessary, to the level of the ground surface.

2.4.7 PROTECTIVE CASING

A lockable protective casing will be set into the grout seal surrounding the well. The casing will be made of steel pipe with a lid capable of being locked. The diameter and length of the pipe will be determined by the type of well and conditions encountered in the field. The casing will be cleaned of all foreign matter prior to use. It will extend into the ground at least 3 ft below the ground surface and will extend about 2 ft above the ground surface. The well will be padlocked from the date of installation of the protective casing. After installation, the outside of the protective casing will be painted white, and the well identification will be painted black. All painting will be with a paint brush not with an aerosol can.

Aggregate cement will be poured to a depth of about 0.5 ft in the annular space inside the protective casing and outside the well casing to form a pad 4-ft in diameter and about 0.25 ft thick. A 0.250-inch diameter drainage port will be drilled in the protective casing just above the level of the cement collar.

2.5 WELL DEVELOPMENT

Upon completion of the well installation, the monitoring wells will be developed at least two weeks prior to sampling and according to procedures described in USATHAMA Geotechnical Requirements (USATHAMA, 1983). Well development will be conducted by means of either a submersible pump or a bottom discharge bailer, with or without a surge block.

The volume of standing water in the well sand pack and annulus will be removed a minimum of five times. If any water was added and lost during drilling or completion of the well, five times this volume will also be removed during development. The wells will be developed until the water is clear and as sediment free as possible, and any remaining sediment obstructions are no more than 5 percent of the total screen length.

Measurements obtained and recorded will include static water levels before and after development, field pH, and conductivity measurements before, during, and after development. For each well, a 1-pint sample of the last

water to be removed during development will be collected and retained. Appropriate forms and other pertinent data will be submitted to PMO-RMA or an authorized representative in accordance with USATHAMA Geotechnical Requirements.

2.6 MONITOR WELL IDENTIFICATION

Upon completing of the installation of the final well, each well location and the elevations of ground surface on top of the well casing will be surveyed by a professional land surveyor registered in the State of Colorado. International Technology Limited (ITECH) of Englewood, Colorado, is the designate surveying subcontractor for this RMA task order.

The well identification number, map coordinates, and elevation will be recorded in a field log book and data submitted to PMO-RMA. An aluminum survey cap will be stamped with the tag number and elevation, then set on a 2-ft rebar flush into the well's concrete apron.

2.7 ABANDONMENT

The abandonment of boreholes and wells will be approved by the Contracting Officer prior to any casing removal, sealing, or backfilling. Once removed, the borehole or monitor well to be abandoned shall be sealed by grouting from the bottom of the bore well to ground surface. This shall be conducted by placing a grout pipe (tremie pipe) to the bottom of the borehole or well (i.e., to the maximum depth drilled/bottom of well screen) and pumping grout through the grout pipe until undiluted grout flows from the borehole or well at ground surface. Any open or ungrouted portion of the annular space between the well casing and borehole will also be grouted in the same manner. After grout placement, the grout pipe, augers, and well casing will be removed.

After 24 hours, ESE will check the abandoned site for grout settlement. Any settlement depression shall be filled with grout and rechecked 24 hours later. This process shall be repeated until firm grout remains at ground surface.

2.8 DISPOSAL OF CUTTINGS, MUD, AND WATER

If soil materials encountered or water produced during drilling is considered to contain no chemical constituents, no special handling or disposal is required. All work areas around the well sites will be restored to physical conditions equivalent to that of pre-installation. This includes the spreading of cuttings, removal of ruts, and reseeding the disturbed areas. When drilling in known contamination plumes, all drilling by-products will be handled in accordance with USATHAMA guidelines and Task 32 (Wastewater Disposal).

2.9 FIELD DOCUMENTATION

All field personnel will be required to maintain a written record of their daily activities. All records will be kept on prepared forms and will be signed and dated by the field personnel at the end of the day. Appendix C contains examples of appropriate records and report forms.

The Site Geologist will maintain a Record of Activities at the Drill Site on which a time record of all drill site activities will be kept. The Site Geologist will also prepare as necessary, a Borehole Summary Log, Well Construction Summary, Soil/Core Sample Chain-of-Custody, Borehole or Well Abandonment Report, and a Drill Site Geologist Daily Report.

All other field personnel will maintain a Daily Activities Summary. The geologist logging the soil samples will use the Soils Log and Core Log to prepare detailed descriptions of samples following USATHAMA guidelines. The well development team will record development data on the Well Development Data form.

2.10 SURFACE GEOPHYSICS AND CONE PENETRATION TESTS

One or more shallow focus geophysical techniques and/or cone penetration tests (CPT) are being considered to supplement data obtained from the monitoring well and borehole program. The primary function of these investigations will be to help locate and define the bedrock surface in high contamination areas north of the RMA northern boundary. In particular, these techniques would be used to further locate and define alluvium-filled

paleovalleys that may be serving as conduits for the north and northwestern migration of contaminants. Two methods of surface geophysics, electrical method (EM-34) and microgravity, are being considered. Both methods have been employed previously to successfully predict bedrock topography at or near RMA. Use of these techniques for this task would depend upon being able to perform successful field verification tests in an area of known topography near the zones of interest. The use of the CPT to determine bedrock topography in the study area is also being considered. Although this is generally not the primary application of the CPT, it may prove to be a reliable and cost-effective means of determining bedrock elevations and subsurface stratigraphy. Therefore, its overall usefulness may be evaluated on a limited scale during this task to provide recommendations for future work.

2.11 AQUIFER TESTS

Pumping tests are proposed for approximately three alluvial well locations in the study area. These tests are considered the most reliable method for estimating aquifer hydraulic conductivity. By observing water levels near the pumping wells, an integrated hydraulic conductivity over a sizable aquifer section can be obtained. This method will provide the most accurate data for use in ground-water models and subsequent evaluation of remedial action alternatives. These tests would be used in conjunction with existing data from the Offpost CAR (ESE, 1987, RIC#87202R01) and the borings for this task to determine the magnitude and variations in transmissivity for the study area.

The specific locations for alluvial aquifer tests would be based upon the following criteria:

- o Areas where aquifer characteristics are unknown or very poorly defined;
- o Areas that are likely to be effected by any proposed remedial action; and
- o Areas where additional aquifer data would significantly contribute to the understanding of offpost contamination migration trends and patterns.

Values of the storage coefficient and transmissivity of the aquifer would be calculated from pumping test data by solving the differential equation applicable to the transient flow problem. The Theis method is the most common analytical technique used to solve the governing equation and will be used where appropriate to determine hydrogeologic parameters.

Waste water from the pumped tests will be handled as directed by PMO-RMA. At present, alternatives being considered for handling contaminated water are drumming and/or running the water through the NBTS.

3.0 GROUND-WATER SAMPLING

3.1 SAMPLING PROCEDURES

Ground-water sampling methodology and techniques adhere to USATHAMA Geotechnical Requirements with respect to decontamination, collection, preservation, shipment, and chain-of-custody requirements. Further discussion of these aspects of sample collection is provided in the Task 4 Technical Plan (ESE, 1986a, RIC#87013R01).

The following is a summary of the sampling procedures to be used in the investigative program:

- Sampling crews receive labeled sample kits from Field Team Coordinator;
- Record well number, date, pertinent information (e.g., weather and well conditions), station elevation, casing diameter, screened interval, and field equipment identification (manufacturer and ID number);
- Measure and record well stickup, depth to water, total well depth, HNU readings, and calculate well casing volume;
- Lower submersible pump to a few feet below the maximum drawdown or to the bottom of the well. If well is constricted above water level and pump will not pass, lower bailer to a few feet below water level. Record depth to pump or bailer;
- Pump or bail 5 casing volumes out of well. Measure and record time, pH, conductivity, and temperature after each well volume. Measure and record HNU readings by obtaining frequent background, well head, and discharge water values. If well is located within a known contamination plume or if HNU readings are obtained above background levels, discharge water will be collected in barrels. Otherwise water may be discharged on the ground at least 50 ft from the well head;
- Measure and record pumping rate, total pumping time, and total volume purged;
- Remove pump after purging is completed or if well is dewatered;

- o Sample immediately, or if well was dewatered, sample when water level has recovered. Sample using bottom filling stainless steel bailer. Measure pH, conductivity, and temperature of water sample obtained from bailer being used for sampling. Record time and measured values on sampling sheet, in field notebook, and on sample labels;
- o Decant portion of water into sample bottles; cap bottles, agitate bottles, and discard water. Fill rinsed sample bottles directly from bailer. Record sample depth;
- o Place bottles in ice chest;
- o Complete chain-of-custody forms;
- o Sign and date well sampling form; and
- o Seal cooler and ship samples.

All pertinent data obtained during ground-water sampling has been recorded on Field Sampling Data sheets and kept in a bound field notebook. The information recorded for each well sampled includes:

- o Well number;
- o Date and time (24-hour system);
- o Pertinent observations (e.g., weather, well condition);
- o Station elevation;
- o Well stickup;
- o Static water level and well depth;
- o Casing diameter;
- o Number of gallons per casing volume;
- o Screened interval;
- o HNU readings;
- o Pump depth, measured pumping rates, total pumping time and total volume of water removed;
- o Characteristics of the water (color, odor, etc.);
- o Measurements of pH, temperature, and conductivity;
- o Identification of field equipment;

- o Sampling description (number of bottles, sample fractions, sample depth);
- o Field notebook number; and
- o Signature of samplers and Field Team Coordinator.

Records have been kept of all wells visited, including those found to be dry or constricted such that sampling was impossible. Dry wells include those wells with the water level below the bottom of the screened interval.

3.2 SAMPLE SHIPMENT/CHAIN-OF-CUSTODY

The Site Geologist will serve as Sampling Team Leader and will supervise and assist in the sampling of all ground water and surface water sampling stations. Samples will be labelled, filtered, and preserved in the field. A log sheet will be filled in and signed by the Site Geologist to serve as a check that all samples and operations are complete. Samples will be packed in styrofoam ice chests with sufficient ice to maintain less than 4 degrees centigrade (°C) during transport to the laboratory. The ice will be double-bagged to prevent contact of the melt water with the samples. All samples will be checked for integrity and lid closure to prevent leakage.

The sampling logistics will occur as follows. The time elapsed between the first sample collection and initiation of processing in the laboratory will be approximately 24 to 30 hours, based on transportation schedules.

The Chemical Analysis Supervisor will be notified of the shipment of samples and estimated time of arrival of the sample being driven. The Chemical Analysis Supervisor or a designate will receive the sample, verify the contents, and sign the log sheet. Samples are stored at ESE in a 4 °C refrigerator under the control of the Data Management Supervisor in the Sample Control Center. The procedures for sample fraction control during analysis are described in the Data Management Plan in Volume I of the Task 1 Technical Plan (ESE, 1985a, RIC#85127R01).

Any samples which are leaking, any situations in which holding times are not met, or other problems which may compromise the data, are noted at the time of receipt of the samples and reported to the Quality Assurance (QA) Supervisor for development of corrective action. The QA Supervisor verifies the chain-of-custody record of each sample set.

4.0 CHEMICAL ANALYSIS

The objective of the analytical program is to provide PMO-RMA with reliable, statistically supportable, and legally defensible chemical data regarding type and level of ground-water contamination in the areas offpost of RMA. To achieve this goal, a schedule of 50 substances has been chosen. These substances include 52 analytes. The modified analytical schedule of 50 substances includes 7 organochlorine pesticides, DCPD, MIBK, DIMP, DMMP, DBCP, 6 organosulfur compounds, 5 volatile aromatics, 12 volatile organohalogens, and 15 inorganic parameters (Table 4.0-1).

Table 4.0-1. Chemical Analysis - Task 39 (Page 1 of 2)

Analysis/Analytes	Hold Time	Level of Certification	Reference Methods	Method
Organochlorine Pesticides		Quantitative	USATHAMA 58/MM8A	CAP-GC/ECD
Aldrin	Extract as quickly as possible. (No more than 7 days). Analyze within 30 days of extraction.			
Endrin				
Dieldrin				
Isodrin				
Hexachlorocyclopentadiene				
p,p´-DDE				
p,p´-DDT				
Chlordane				
Volatile Organohalogens		Quantitative	USATHAMA Y8/TT8	PACK-GC/Hall
Chlorobenzene	14 days			
Chloroform	14 days			
Carbon Tetrachloride	14 days			
trans-1,2-Dichloroethylene	14 days			
Trichloroethene (TCE)	14 days			
Tetrachloroethene	14 days			
1,1 Dichloroethene	14 days			
1,1 Dichloroethane	14 days			
1,2 Dichloroethane	14 days			
1,1,1 Trichloroethane	14 days			
1,1,2 Trichloroethane	14 days			
Methylene Chloride	14 days			
Organosulfur Compounds		Quantitative	USATHAMA U8/PP8A	PACK-GC/FPD-S
P-Chlorophenylmethylsulfone ($PCPMSO_2$)	Extract as quickly as possible. (No more than 7 days.) Analyze within 30 days of extraction.			
P-Chlorophenylmethylsulfoxide (PCPMSO)				
P-Chlorophenylmethylsulfide (PCPMS)				
1,4-Dithiane				
1,4-Oxathiane				
Dimethyldisulfide (DMDS)				
Benzothiazole				
Volatile Aromatics				
Benzene	14 days	Quantitative	USATHAMA W8/SS8	PACK-GC/PID
Toluene	14 days			
m-Xylene	14 days			
o,p-Xylene	14 days			
Ethylbenzene	14 days			

Table 4.0-1. Chemical Analysis - Task 39 (Page 2 of 2)

Analysis/Analytes	Hold Time	Level of Certification	Reference Methods	Method
DCPD/MIBK		Quantitative	USATHAMA Z8/R8	CAP-GC/FID
Dicyclopentadiene/ Methylisobutylketone	Extract as quickly as possible. (No more than 7 days). Analyze extract within 30 days of extraction.			
DIMP/DMMP		Quantitative	USATHAMA T8/QQ8	PACK-GC/FPD-P
Diisopropylmethylphosphonate/ Dimethylmethylphosphonate	Extract as quickly as possible. (No more than 7 days). Analyze within 30 of extraction.			
DBCP		Quantitative	USATHAMA V8/Q8	CAP-GC/ECD
Dibromochloropropane	14 days			
Inorganics		Quantitative	USATHAMA X8/NN8	
Chloride	28 days			Ion Chromatography
Fluoride	28 days			Ion Chromatography
Sulfate	28 days			Ion Chromatography
Nitrate	28 days		USATHAMA K8	Auto Analyzer
Metals				
Arsenic	6 months	Quantitative	USATHAMA A8/W8	AA-Hydride Furnace-GNV AA-Graphite Furnace-DEN
Calcium	6 months	Quantitative	USATHAMA B8	Ion Chromatography
Sodium	6 months			Ion Chromatography
Magnesium	6 months			Ion Chromatography
Zinc	6 months			Ion Chromatography
Cadmium	6 months			Ion Chromatography
Lead	6 months			Ion Chromatography
Chromium	6 months			Ion Chromatography
Copper	6 months			Ion Chromatography
Potassium	6 months	Quantitative	USATHAMA AA8/XX8	Flame-AA
Mercury	28 days	Quantitative	USATHAMA L8/WW8	Cold Vapor Auto Analyzer

Source: ESE, 1987.

5.0 QUALITY ASSURANCE

QA for Task 39 will be consistent with the Field/Laboratory QA Plan developed for Task 1 activities. The plan is project specific and describes procedures for controlling and monitoring sampling and analysis activities as required under Task 39. As designed, the Field/Laboratory QA Plan will ensure the production of valid and properly formatted documentation concerning the precision, accuracy, and sensitivity of each method used for USATHAMA sampling and analysis efforts. The plan is based on the USATHAMA 1982 QA program requirements as modified by U.S. Army AMCCOM Procurement Directorate and ESE as well as certified analytical methods submitted to and approved by USATHAMA. The plan is presented in Appendix B of the Task 1 Technical Plan (ESE, 1985a, RIC#85127R07). Specific RMA QA requirements are detailed in Section 5.0 of the same document.

6.0 SAFETY PROGRAM

The purpose of the safety program described in this section is to summarize the safety, accident, and fire protection standards and procedures, and to outline standard operating procedures to ensure the safety of all personnel performing Task 39 activities. Responsibilities, authorities, and reporting procedures designated for Task 39 are identical to those in Section 7.0 of the Task 1 Technical Plan (ESE, 1985a, RIC#85127R07).

The program addresses all of the requirements of DI-A-5239B and fully complies with requirements of the Occupational Safety and Health Act (OSHA) and U.S. Army Material Development and Readiness Command (DARCOM) Regulation 385-100, Army Regulation (AR) 385-10, and Department of Army Pamphlet (DA-PAM) 385-1 for all activities to be conducted. The program also complies with the ESE Analytical Laboratory Safety Plan.

6.1 STANDARD PROCEDURES

6.1.1 WASTE CHARACTERISTICS

In the 43 year history of RMA, many hazardous chemicals were manufactured, stored, or partially destroyed in demilitarization activities. Key compounds include GB and other nerve agents; H and L blister agents, munitions, organophosphorus pesticides and herbicides, phosgene, hydrazine, heavy metals, and chlorinated and unchlorinated organic solvents. High levels of organics have been detected off RMA property in the area that Task 39 is concentrated. It is likely that some of these compounds may be encountered during the sampling and drilling activities to be carried out under Task 39. Detailed information on the chemical agents is given in the Agent Fact Sheet, SMCRM Form 357 (RMA, 1984) and Military Chemistry and Chemical Agents, TM 3-215 and AFM 355-7 (U.S. Departments of the Army and the Air Force, 1963). Copies of this information will be available at the Support Trailer at RMA.

6.1.2 GENERAL PROCEDURES

Task 39 activities include geophysics, deep and shallow soil borings, well installation and development, and water sampling outside RMA boundaries. These activities could expose field personnel to contaminated soils and ground water. Because of this hazard, specific safety procedures are outlined later in this section. Communication requirements and buddy system procedures will remain the same as those detailed in the Task 1 (ESE, 1985a, RIC#85127R07) and Task 4 (ESE, 1986a, RIC#87013R01) Technical Plans.

6.1.3 SURFACE GEOPHYSICS

Surface geophysics will not include any activity which will disturb the ground. Because all of this work will be completed offpost under Task 39, Level D personal protection will be worn by field crews. The only requirement is that field crews will wear steel toe and steel shank rubber boots.

6.1.4 DRILLING OPERATIONS

Soil borings and well installations will include using both auger and air rotary drilling techniques. General procedures to be followed when working on the drill rig are as follows:

- o Daily inspection of all ropes, cables, bolts, and moving parts of the rig is mandatory;
- o Hard hats will be worn at all times in the vicinity of the drilling rig;
- o Goggles or safety glasses will be worn when operating power tools for sanding, grinding, or filing. Welders glasses or a mask will be worn in the vicinity of welding operations;
- o No loose fitting clothing or free long hair is permitted near the rig;
- o Hands will be kept out of the way of moving machinery parts when drilling is in progress;
- o A first-aid kit and fire extinguisher will be available at all times;
- o All crews will consist of at least two persons;

- There will be no smoking, eating, or drinking, except in the base administrative area or the support trailers. In no case will smoking materials or matches be disposed of onsite; and
- No drilling will occur during impending electrical storms or when rain or icing conditions create a hazard in working with equipment.

Because of the different hazards involved with each type of drilling, technique-specific safety procedures will be followed. The following sections describe the different procedures.

Shallow Soil Borings

Two types of soil borings will be completed under Task 39. These include shallow borings and deep borings which are drilled through the water table. During the completion of the shallow soil borings, field crews will don Level D protection which will include steel shank and steel toe boots. Monitoring with an HNU will be done by the Site Geologist every 5 ft of drilling.

Auger and Water Rotary Drilling During Well Installation and Deep Soil Borings

Auger and water rotary drilling will be used whenever possible due to the fact that material from the hole is easier to collect and contain, and remains at ground level. Well installation and deep borings for Task 39 will take place in areas where the soil is largely uncontaminated. Ground water, however, in these areas is contaminated. Level D protection with steel toe and shank boots may be worn until drilling reaches a depth of 20 ft above the estimated water table depth. At this time, field personnel will don the following protective clothing and equipment:

- Saranex coated coveralls;
- Hard hat with face shield;
- Steel toe, steel shank boots;
- Latex rubber boot covers;
- Two pairs of chemical resistant gloves;

- o Full-face, air purifying respirator with Scott 642-OV-H chemical cartridges (readily available);
- o Fifteen-minute escape pack (readily available); and
- o Safety glasses when face shield is not needed to protect the eyes.

The Site Geologist has responsibility for air monitoring and general safety during drilling. Monitoring, using the HNU or TIP photoionization detector, will take place at least every 10 ft of drilling until water is encountered. Once water is encountered, monitoring will be continuous until the total depth of the hole is reached.

When levels of organic vapors reach above background up to 5 parts per million (ppm) in the breathing zone, full face air purifying respirators will be worn. Field crew members will be required to don Level B protection where vapor levels are 5 ppm to 500 ppm in the breathing zone.

Air Rotary Drilling During Well Installation

Air rotary drilling techniques will be used where auger drilling cannot (e.g., drilling through bedrock). Air rotary ejects soil, mud, and water from the hole with great force. Because of the much greater possibility of contacting contaminated materials during air rotary, safety procedures will differ from auger drilling. The following equipment will be worn as full Level C protection:

- o Hooded Saranex coated overall;
- o Full face, air purifying respirator;
- o Hard hat;
- o Steel toe, steel shank rubber boots;
- o Latex rubber boot covers;
- o Chemical resistant gloves; and
- o Fifteen minute escape pack.

Air monitoring will be extremely difficult because neither the HNU or the TIP can get wet. There is also a danger of aspirating water or mud into the unit. While water and soil is being ejected from the borehole, no monitoring will take place in order to protect the instrument. During this

time, full Level C protection will be worn. Also, in addition to the Saranex suit, drilling personnel will be required to wear a butyl rubber jacket over the Saranex suit to help repel the water. Other personal working in the vicinity of the rig will be evaluated as to whether they will need a rubber jacket. These procedures will be followed whenever downhole material is being ejected from the boring.

Well Development and Water Sampling

The greatest hazards from well development and well sampling will be through skin contact with contaminated ground water and inhalation of volatile compounds being stripped from the water as it is being purged from the well. Field team members will don full Level C protection when approaching a well and removing its cap. The crew will then monitor the breathing zone and downhole to determine the airborne hazards. Guidelines described for auger drilling will also apply to further respiratory protection.

When respirators are not worn, full face shields will be worn to protect the face from being splashed with contaminated water. Air monitoring will take place when well casing volume is removed from the well. Detailed procedures for ground-water sampling can be found in Section 7.0 of the Task 4 Technical Plan (ESE, 1986a, RIC#87013R01).

6.1.5 HOTLINES

Hotlines will be established in a circular fashion around each deep soil boring and well. For auger drilling, well development, and sampling, the hotline will be a 30-ft radius around the well. Air rotary drilling activities will require a 50-ft radius hotline around the well. The required personal protection will be worn by all individuals within these hotlines.

If deep soil borings and well installation requires both auger and air rotary drilling, the hotline can be modified as drilling progresses but only in an increased fashion. In other words, if the hotline starts out at a 30-ft radius, it can be enlarged to 50 ft when air rotary drilling begins. However, a hotline cannot be made smaller on the same well. Once the

hotline is 50 ft, it will remain that way for the remainder of the boring or well installation. The Site Geologist will have the responsibility of establishing and enforcing the hotline.

6.1.6 DECONTAMINATION PROCEDURES

Decontamination procedures will follow those procedures outlined in the Task 4 Technical Plan (ESE, 1986a, RIC#87013R01), Section 7.0. In summary these procedures are as follows:

- Vehicle seats and floorboards will be covered with plastic to aid in keeping them clean;
- All vehicles, equipment, and personnel entering the hot area will require decontamination;
- An initial decontamination will take place at the well site; and
- Field personnel will remove plastic from the inside of vehicles and proceed to the field wash trailer for showers.

6.2 CONTINGENCY PLANS

6.2.1 CHEMICAL AGENTS AND ORDNANCE

It is highly unlikely that chemical agents or ordnance will be encountered in the Task 39 study area. However, all crews will be supplied with M-8 detector paper as a precaution. The Site Geologists will be required to test formation water with this paper to check for agents in the water.

If chemical agents are detected, the emergency and evacuation procedures posted in the Command Post and field wash trailers, and detailed in the Task 1 Technical Plan (ESE, 1985a, RIC#81527R07) will be followed.

6.2.2 EMERGENCY PROCEDURES AND SERVICES

In the event of an emergency, (i.e., serious injury, fire, agent detection), the first point of contact will be the RMA fire department. For more detailed procedures for emergency situations refer to the Task 1 Technical Plan (ESE, 1985a, RIC#85127R07).

7.0 DATA MANAGEMENT PLAN

Data for Task 39 will be handled according to the Data Management Plan in Volume I of the Task 1 Technical Plan (ESE, 1985a, RIC#85127R07). As outlined in the plan, field data will be entered into an IBM-compatible personal computer (PC) in the ESE Denver office and transmitted to a PC in the ESE Gainesville office via telephone. Field data will be transferred to IR-DMS, subjected to the Geotest data check routine, validated, and placed into Level 2. Sample number assignments, labels, and logsheets will be made in Denver and given to the sampling team. Samples shipped to laboratories will follow chain-of-custody procedures described in Section 4.2 and the Task 1 Technical Plan. Data from laboratory analyses will be entered into the ESE Prime 750, incorporated with certification and field data, and formatted into files according to the IR-DMS User's Guide. After validation these files will be sent to the Univac using an IBM-PC, run through the data-checking routine, and elevated to Level 2.

8.0 DATA EVALUATION

The new data gathered from water sampling and soil borings will be combined with existing data and data from other programs to achieve the objectives established for the monitoring program in Sections 2.0 and 3.0. Evaluation of the data will be simplified by incorporating new geologic, hydrologic, and chemical data into revised maps and cross sections which show geologic and hydrogeologic features and the boundaries of contaminant plumes.

Geologic sections will be generated and revised to incorporate all borings information from the proposed RI program. These sections will further define the bedrock surface and the location, extent, and configuration of units of the Denver Fm. Geologic information will be interpreted to determine how offpost Denver Fm aquifers conform with units found onpost.

Measurement of ground-water elevations will be obtained in the alluvial aquifers offpost to better define the water table and alluvial ground water patterns. Piezometric data will also be obtained for bedrock wells to provide an indication of the magnitude of vertical gradients between aquifers. This information will be beneficial in determining how the aquifers interact in areas where Denver Fm sand units subcrop into the alluvium north of RMA. Piezometric data will be implemented into maps and cross sections to facilitate interpretations and clarify offpost ground-water flows and patterns. Ground-water modeling will focus on the alluvial aquifer in the areas north of RMA, and will assist EA and FS activities.

Due to the sparsity of contaminant transport data available for the offpost area, the model will not consider the solute transport. It will instead emphasize further definition of ground-water flow patterns and evaluating the effectiveness of any remedial action alternatives proposed for the alluvial aquifer.

The pumping tests proposed in the Geotechnical Section (Section 2.0) would be a primary source of hydrogeolgical data for the ground-water model. It is evident from the complex hydrogeology in the offpost area that many

aquifer tests would be required to properly define input parameters for an accurate model. Due to the limited number of aquifer tests proposed for this task, it is recommended that these tests be conducted in areas where the data is essential to a reasonable assessment of remedial actions. MODFLOW, a finite difference model with quasi 3-dimensional capabilities, has been chosen for the modeling effort. The modeling will be performed by Harding Lawson Associates (HLA).

Contaminant transport will be evaluated by addressing the ground-water flow patterns in contaminated areas and addressing the gross transport characteristics of individual contaminants of concern. This approximate assessment will be utilized to address contaminant migration trends and develop remedial action alternatives that will effectively mitigate offpost contamination.

PART III - ENDANGERMENT ASSESSMENT
(SECTION 9.0)

9.0 ENDANGERMENT ASSESSMENT

The objective of the EA is to characterize the magnitude and probability of actual or potential harm to public health, welfare, or the environment from RMA contaminants. The primary pathways for contaminant releases from RMA appear to be from ground water and surface water based upon the Offpost CAR (ESE, 1987, RIC#87202R01). Other pathways such as air, biota, and soil/sediments will be evaluated based upon the data collected under other RI tasks at RMA. The assessment will be conducted in accordance with relevant EPA guidance documents including:

- o The Endangerment Assessment Handbook;
- o The Exposure Assessment Manual;
- o The Toxicology Handbook; and
- o EPA Exposure and Risk Assessment Guidelines.

The assessment will be conducted so as to be similar in scope and level of detail with the onpost EA. Technical consistency with the results of that study will also be maintained, specifically with respect to:

- o Assumptions regarding future land use and exposure routes;
- o Quantitative toxicological assessment expressed as acceptable daily intakes and unit cancer risks; and
- o Chemical-specific environmental fate properties of toxicants.

The core activity under the EA task is a review, interpretation, and summary of information pertinent to the risks posed by contaminants released from RMA. Pursuant to this activity, and in support of the FS, criteria for appropriate pathways will be developed for the offpost study area. Recommended ground-water quality cleanup goals for offpost ground-water remediation are currently being developed and will soon be presented to the Organizations and the State (OAS) parties for comment. These cleanup goals may incorporate applicable or relevant and appropriate federal and state requirements (ARARs) to the extent such standards must be attained pursuant to Section 121 of SARA. A determination of which federal or state ARARs must be attained by the final remedy selected for offpost ground water will also be presented to the OAS parties for comment. Where ARARs do not exist

for specific contaminants, water quality cleanup goals will be established for those contaminants based on the risk assessment procedures discussed below. The EA Report will present these cleanup goals as guidelines for the FS. The EA will also consider the most probable land uses and the range of potential uses as they may affect exposure potential.

Activities under the EA subelement consist of four separate components:

- Contaminant identification;
- Exposure assessment;
- Toxicity assessment; and
- Risk characterization.

This organization will allow for comprehensive integration of hydrogeologic contaminant and population information in order to adequately assess risk to public health, welfare, and the environment. The scope, approach, and types of results to be achieved by each of these components are discussed further in the following sections.

9.1 CONTAMINANT IDENTIFICATION

Contaminants of concern are defined as those contaminants that have migrated from RMA in potentially harmful concentrations. Although air, biota, and soils/sediments may be potential pathways, and will be assessed, the EA will focus primarily on ground and surface water pathways. For this reason subsequent sections refer primarily to the water pathway component. Contaminants of concern will be identified based on the following criteria:

- Contaminants that have been observed in ground water or surface water migrating across RMA's north or northwest boundaries;
- Contaminants exhibiting a spatial pattern similar to contaminants which have been documented to have migrated across the boundary; and
- Contaminants found offpost which have been documented to have been associated with RMA onpost activities.

This list will be prioritized, and some contaminants may be deleted as the assessment proceeds based on the following:

- Contaminants with concentrations within the range observed at sites upgradient of RMA;
- Contaminants for which the maximum concentration is significantly less than applicable cleanup levels; and
- Contaminants found offpost which have no plausible pathway from Arsenal sources.

An indicator contaminant screening, as recommended by Superfund Public Health Education Manual (SPHEM), will be performed. All offpost contaminants, however, will be addressed in the EA. Indicator contaminants will be addressed in greater detail.

Solvents and pesticides observed offpost may derive from offpost sources unrelated to RMA. The spatial pattern of contamination and the plausibility of transport pathways from RMA, as well as a limited review of readily available information characterizing offpost sources, will be considered in evaluating cause/effect relationships between offpost contaminants and RMA. For example, the South Adams County agricultural extension agent will be interviewed to determine which pesticides are, or have been, commonly applied in the study area. Industrial or commercial facilities that routinely use solvents will be identified in specific portions of the study area where anomalous contaminant levels have been observed. Sites on CERCLA's National Priority List (NPL) and municipal landfills in the study area will also be identified.

9.2 EXPOSURE ASSESSMENT

The Exposure Assessment component of the EA will require the most significant level of effort within the EA and will encompass the following components:

- Identification of populations at risk, including human and nonhuman receptors;
- Land use/demographic projections;
- Exposure pathway identification and description;

- o Existing contaminant distributions;
- o Contaminant fate and transport assessment;
- o Projected future contaminant distributions; and
- o Chronic dose estimation.

Some of the information identified here will be collected during previously described offpost RI tasks and will be used in the EA evaluation. Integration of these components results in the assessment of potential ranges and most probable levels of exposure to contaminants by the receptor populations.

9.2.1 POPULATIONS AT RISK

Populations at risk may include:

- o Humans (existing and projected future residents and workers);
- o Livestock;
- o Aquatic biota;
- o Waterfowl; and
- o Endangered species.

Within these categories, high-risk subpopulations such as cattle, resident ducks in Barr Lake, or bald eagles, will be identified based upon probability of exposure and documented sensitivity to identified contaminants. Subsequent risk characterization will focus on high-risk subpopulations.

9.2.2 LAND USE/DEMOGRAPHIC PROJECTIONS

The assessment will be based upon South Adams County land use planning documents and projection of historical development trends. Analogous projections performed for the onpost EA will be reviewed with an emphasis on the offpost study area. Census data will be reviewed and summarized. Existing and projected future populations at risk will be estimated. The timeframe for population projections is to be determined by consideration of:

- o Existing projections by local planning agencies;
- o Estimated residence time of contaminants of concern under the no-action alternative; and
- o Relevant exposure durations for chronic effects.

9.2.3 EXISTING CONTAMINANT DISTRIBUTION

Presentation of the contaminant distributions is required for the EA report and suitable presentation formats will be developed in this task. Contaminant distributions will be interpreted to evaluate the association of observed contaminants with onpost RMA activities. Data management and data evaluation is performed under separate subelements, so the focus of this subcomponent is coordination to ensure that data presentation formats are suitable for the EA report.

9.2.4 CONTAMINANT FATE AND TRANSPORT ASSESSMENT

The objectives of the contaminant fate and transport assessment are to:

- o Evaluate available data to determine whether existing contaminant distributions are attributable to known sources at the RMA boundary;
- o Develop quantitative data, including uncertainty distributions, suitable for exposure pathway quantification and PPLV criteria development; and
- o Develop a quantitative basis to project future contaminant distribution in the study area under the no-action alternative.

These activities will involve review and interpretation of the results of all previous assessments of contaminant transport through ground water and surface water systems in the study area. The extent to which these prior investigations are able to explain the existing contaminant distribution in the study area will be evaluated. Independent assessment of contaminant fate in biotic systems will be performed as well as environmental fate process such as volatilization from ground water and adsorption to soil and aquifer materials. Literature surveys will be conducted regarding the environmental fate of contaminants of concern to supplement reviews already performed by U.S. Army Bioengineering Research and Development Laboratory (USABRDL). An uncertainty analysis of the environmental/chemical specific

parameters controlling fate and transport quantification of exposure pathways will be performed. This uncertainty analysis is one component of the Preliminary Pollutant Limit Value (PPLV) development and the risk characterization component. Chemical-specific parameter uncertainty distributions, developed for the onpost EA, will be used to the extent that the same chemical-specific parameters also affect exposure pathways pertinent in the offpost study area.

Literature pertaining to food web relationships and uptake of waterborne contaminants by vegetation, wildlife, and livestock will be reviewed, interpreted, and summarized to support the exposure pathways quantification for high-risk populations. Onpost tissue analysis data will be evaluated for relevance in assessing uptake by offpost populations. Close coordination with the onpost biota assessment will be maintained to assure consistency within the RI tasks.

9.2.5 EXPOSURE PATHWAY IDENTIFICATION

For each of the high-risk populations, plausible exposure pathways will be hypothesized. A method for quantifying exposure by each pathway will be presented using methods consistent with the PPLV approach to the extent quantification is feasible. Critical data gaps affecting dose quantification will be identified.

9.2.6 PROJECTED FUTURE CONTAMINANT DISTRIBUTIONS

To the extent that the contaminant fate and transport assessment demonstrates an ability to explain or reproduce existing contaminant distributions, the results will be used to project future contaminant distribution under the no-action alternative. The methodology to be used, and the degree of precision anticipated, cannot be specified at this time. The effect of planned development of ground-water supplies by South Adams County would be predicted.

Ultimately, if it proves impossible to reconstruct the existing contaminant distribution from known sources and documented ground-water flow systems, there would be no reliable basis for prediction. Such a finding would suggest that the ground-water flow system or the evaluation process is not

adequately understood to support a reliable prediction. In this case, which would indicate great uncertainty in the fate and transport assessment, it may be necessary to rely on worst-case estimates, that is, the population at risk will be exposed to the maximum observed concentrations.

9.2.7 ESTIMATE CHRONIC DOSES

This task is related to the PPLV criteria development. Exposure factors must be documented and uncertainty distribution determined. Combinations of single pathways appropriate for various water uses will be defined. Pathway quantification and uncertainty analysis will be performed to characterize the range of exposure possible for the population at risk. The stochastic uncertainty analysis will utilize software developed for the onpost EA. This software will be made available by the Army in an IBM-PC compatible version and the source code will be provided and documented so that modifications can readily be made to evaluate the exposure pathways relevant to the offpost EA.

9.3 TOXICITY ASSESSMENT

The toxicity assessment for this task will draw directly on assessments already performed by USABRDL and by contractors conducting the onpost EA. Additional effort is anticipated for migrating contaminants that do not pose a significant hazard in soils, including chloride and fluoride. Although, detailed toxicological documentation has not been prepared for these contaminants during the onpost assessment, it will be required for the offpost assessment. A toxicological profile documenting acceptable doses, risk reference dose values, chronic intake values, and cancer potency factors will be prepared for all contaminants of concern, as defined in Section 9.1. Separate sections on human health effects and toxicity to wildlife will be prepared. Toxicological profiles prepared for the onpost EA or by USABRDL may be simply reproduced to satisfy this requirement.

9.4 RISK CHARACTERIZATION

The risk characterization culminates the efforts of previous components of the EA. Quantitatively, the risk characterization is based on a comparison of observed or projected future contaminant levels with PPLV which will be computed as part of this component. The comparison provides a measure of

individual risk. Combining this result with the estimated population at risk can provide some measure of the aggregate risk. The analysis is complicated by several factors including:

- Exposure levels are not constant as the contaminant migrates;
- The exposed population may increase with time in this growing metropolitan area, while the dose may decrease with time as the contaminants disperse;
- Exposure levels within even a relatively homogeneous population can vary dramatically as a result of differences in behavior affecting exposure; and
- Level of exposure would be uncertain even if behavior was well defined because of uncertainties in quantifying processes affecting contaminant transfer along the exposure pathway.

The risk characterization will contain two distinct comparisons. The first, and simplest, is a comparison of a single-valued criterion developed from conservative assumptions, with observed and projected maximum concentrations. This analysis is consistent with regulatory policy-based guidance and essentially determines whether the no-action alternative results in an acceptable risk.

The second, and more complicated, characterization will consider the variability in exposures and the uncertainties in exposure calculations. It will be designed to analyze more realistically the probability that an individual residing or working in the study area would receive an unacceptable dose. In this portion of the risk characterization:

- The range of water concentrations will be accounted for: What is the area-time integral of concentration exceeding a specific level?;
- The variety of land/water uses expected in the study area is accounted for: What population will derive potable water from heavily contaminated areas and what population will be exposed via water used for agricultural purposes?; and
- The uncertainty in plant uptake factors will be accounted for: What is the probability that more or less contaminant will be translocated to edible plant portions?

Answers to these questions will, in some cases, be speculative so that detailed quantitative analysis will not be effective. The probability that an individual will experience an unacceptable dose given any specified environmental quality concentration will be evaluated by defining the probability distribution of PPLV across water uses anticipated in the study area. By comparing this distribution with the observed distribution of water concentrations, it is possible to characterize the probability that an unacceptable dose will be realized by an individual. This analysis will be presented as a realistic characterization of risk, in contrast to the simpler, more conservative, policy-oriented comparison described previously.

PART IV - FEASIBILITY STUDY
(SECTION 10.0)

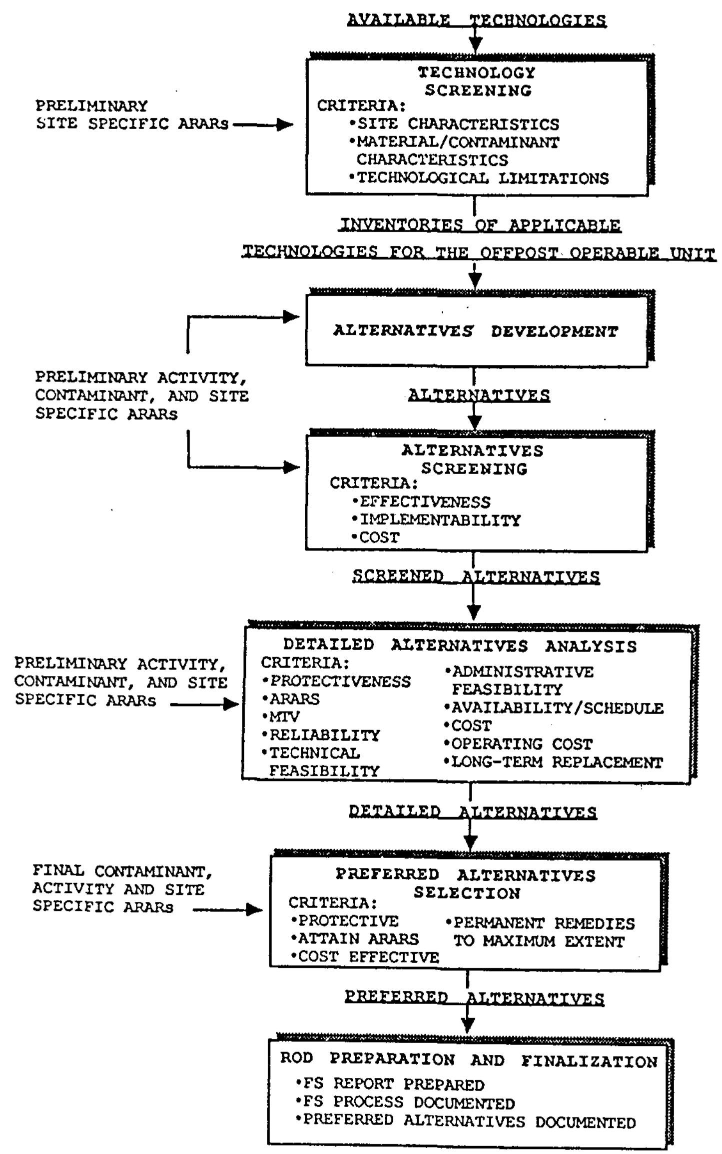
10.0 FEASIBILITY STUDY

The FS process is integrated with and dependent upon inputs from the RI and the EA. The RI will provide data with respect to the type of contaminants, and the location and concentration profiles of these contaminants. The EA will identify the type and level of risks to which human or environmental receptors may be exposed. In addition, where Federal or State ARARs are not available for specific contaminants in a media, the EA will provide a health-based criteria that will be used as a basis for consideration of an action level. These outputs from the RI and EA will be used in the development of specific response objectives which will set the goals for the alternatives to meet.

The purpose of the FS is to select a remedial action alternative for the offpost area through a screening and evaluation process which is protective, cost-effective, and implementable. The FS process will be consistent with applicable FS guidance documents.

Figure 10.0-1 represents the process that will be used in the FS for selection of preferred alternatives. Overall, the process consists of six major steps:

- Identification and screening of technologies;
- Development of alternatives that provide a range of remediation that would, to the degree possible, eliminate the need for long-term management to alternatives involving treatments that would reduce mobility, toxicity or volume;
- Screening of the set of alternatives to minimize the number that will be evaluated in the detailed analysis;
- A detailed analysis of alternatives;
- Selection of preferred alternatives and rationale for selection; and
- ROD preparation and finalization including documentation of the entire FS process.



FS PROCESS DESCRIPTION

The available technologies will be screened against site, material/contaminant, and technological criteria in order to determine the technologies which are appropriate for further consideration. The screening process will eliminate technologies which would never be employed for cleanup of the offpost area either individually or in conjunction with other technologies.

Technologies passing the screening process will be considered in developing alternatives to address response objectives for the offpost area. Response objectives will be established from health-based criteria determined in the EA. Activity-specific ARARs will be identified for technologies considered in alternatives development. The OAS will be allowed to develop alternatives as they feel appropriate.

The remedial alternatives will be compared and evaluated against technical and cost criteria. The most applicable remedial alternatives will be determined and passed on for further detailed evaluation.

The alternatives developed in the previous step, will be developed and analyzed in detail. That is, the alternatives will be more clearly defined by incorporating specific processes and site conditions. The detailed alternatives will be compared and evaluated against technical, regulatory, financial, and cost criteria.

The detailed alternatives that reach this stage will be evaluated and compared relative to cost, technical effectiveness, and regulatory compliance. A preferred alternative will be selected.

The ROD preparation and finalization will involve summarization and documentation of preferred alternatives. The FS efforts conducted to develop and evaluate the alternatives will be documented. Amendments to the ROD, resulting from public review and comment and court decisions, will also be documented here.

Figure 10.0-1
FS PROCESS FLOW DIAGRAM
SOURCE: ESE, 1988

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The FS process will address and accommodate preliminary or temporary remedial actions, such as Interim Response Actions (IRAs). The IRAs will accelerate eventual cleanup and closure of remedial actions by limiting the potential spread of contamination even though such contamination is or may not constitute a present threat to the public health and the environment. The FS alternatives analysis will take into account the IRAs. If, however, the IRAs are not executed by the time the FS is considering a final response action, the final response action will consider the IRAs but will not be driven by the proposed IRAs. The IRAs, in this case, will be consistent with the proposed final response action.

Each of the major steps in the FS are explained in the following sections. The program is flexible and will accommodate future pertinent changes in the regulatory environment, as well as changing site and administrative situations at RMA. The FS for the offpost area will consider the onpost alternatives analysis but will not be dependent upon future onpost actions that are not already planned for implementation.

10.1 TECHNOLOGY INVENTORY AND SCREENING

The purpose of the technology inventory and screening is to develop a comprehensive list of remedial technologies and to screen that list in order to eliminate technologies which would most likely never be useful offpost of RMA. Figure 10.1-1 illustrates the inventory and screening process, and the following sections briefly describe the important steps necessary to develop a list of the most applicable technologies for the offpost area.

10.1.1 TECHNOLOGY INVENTORY

The technology inventory is intended to be a compilation of technologies, either currently available or in the process of development, for remediation of hazardous waste sites. This inventory will be obtained from multiple sources including:

- Published literature;
- PMO-RMA and USATHAMA literature;
- Vendor literature and interviews;

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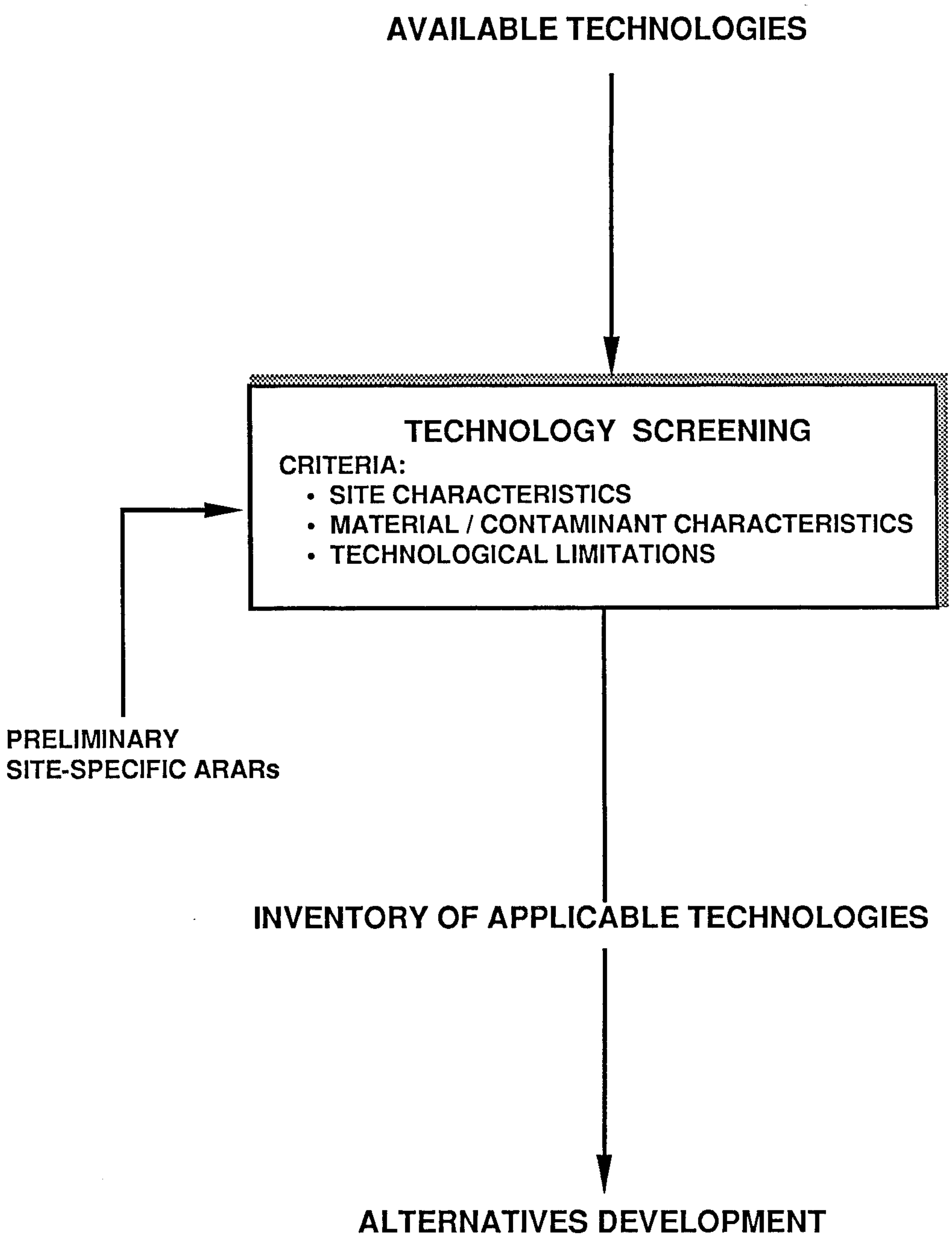

Figure 10.1-1 TECHNOLOGY INVENTORY AND SCREENING SOURCE; ESE,1988.	**Prepared for:** **U.S. Army Program Manager's Office** **For Rocky Mountain Arsenal** **Aberdeen Proving Ground, Maryland**

- o Trade shows and exhibitions;
- o University and research programs;
- o The EPA Superfund Innovative Technology Evaluation (SITE) program; and
- o Input from the OAS.

The first step in the technology inventory will be to list the available remedial technologies that may be useful in the offpost area. Additionally, for each technology, available processes will also be listed. They may be used in later phases of the FS where technologies that do not provide sufficient detail for alternatives development and analysis may be supplemented with representative processes. As an example, the technology of direct treatment will be listed as will the associated treatment processes of air stripping, drying beds, vacuum filtration, steam stripping, and activated carbon and biological treatment.

Some of the available technologies and processes that are identified here may be considered innovative. That is, the technology or process may be in the developmental stage for application to remediation of hazardous wastes, and has very little proven experience in field applications. In such cases, the innovative technologies and process will be identified so that they may be carried through later screening steps with consideration of their special potential for remediating the offpost area.

Technologies will be grouped by media and by the response action. The response actions that will be used in the technology inventory include: removal; disposal; storage; direct treatment; in-situ treatment; containment; and reclamation.

10.1.2 TECHNOLOGY SCREENING

A screening process will be conducted to develop a list of applicable technologies for the offpost area from the inventory of available technologies. Applicable technology, either independently or in combination with other technologies, will provide a reduction in mobility, toxicity, or

volume of the contamination. The list of technologies will be reviewed to determine if each technology would apply to large-scale conditions in the offpost area.

The three major criteria used in the screening process will include:

- Site Characteristics;
- Material/Contaminant Characteristics; and
- Technological Limitations.

The first criteria to be used will be Site Characteristics. Technologies will be eliminated only if a limiting site condition occurs over the entire offpost area. Site Characteristics include:

- Hydrologic Conditions - Local ground water and/or surface water conditions such as depth to water, saturated thickness, and water management practices may be incompatible with certain technologies. Also, hydrologic conditions may not exist that warrant use of a specific technology. In some instances, application of a technology may increase rather than control migration due to hydrologic conditions.
- Geologic Conditions - Because of subsurface conditions, some technologies may be ineffective or cause adverse impacts. Also, geologic conditions may not be technically appropriate for certain surface or subsurface structures.
- Site/Area Configuration - Because of the extremely large area of the offpost area, some technologies are inappropriate for site conditions. Conversely, other technologies may require large areas for implementation, which may not be available because of land ownership. Site configuration, including shape, location, and topography, may not be conducive to implementation of certain technologies.

- Site-Specific ARARs - An identification of preliminary site-specific Federal and State ARARs will be made. Technologies which are not inconsistent with ARARs will be retained for further evaluation. Subsequent additions to ARARs may require reexamination of technologies relative to this criteria.

The second criteria used in each technology screening process will be Material/Contaminant Characteristics. Technologies that do not affect, are hindered by, or do not mitigate contaminants in the offpost area will be eliminated. Material/Contaminant Characteristics used in technology screening will include:

- Physical Condition - Contaminated materials offpost of RMA include liquids, solids, and vapors, or some combinations of these major categories. The effectiveness of a technology is directly related to the physical condition of the material being addressed. In some cases, this may only marginally affect how a technology performs. In other instances, a technology may be completely ineffective or inappropriate for certain materials, and the technology will be eliminated because of the physical condition of contaminated materials offpost of RMA.
- Quantity - The amount of contaminated material may be too large for certain technologies to address feasibly. Conversely, some technologies may require a minimum amount of material before application of the technology is warranted.
- Concentration - The concentration of contaminants in various environmental media offpost of RMA may preclude some technologies from consideration. If the concentrations of contaminants in a given media are too high or too low, some technologies may be ineffective.
- Chemical Composition - Because of certain unique compounds or mixes of compounds that can be expected in the offpost area, some treatment options are not applicable. The presence of a particular compound may render a specific technologies unusable.

Some chemical compounds may change to a more hazardous composition during treatment, thereby making that technology inappropriate. Technologies which disturb the current condition of acutely toxic materials may increase risk to workers or nearby residents.

- <u>Treatability</u> - Treatability refers to compatibility of contaminated materials with remedial technologies, and the ability of those technologies to significantly reduce mobility, toxicity, or volume of contaminated materials. Technologies which cannot reduce these parameters will be considered unsuitable for treatment of the contaminated materials in question.

The last criteria used in each technology screening will be Technological Limitations. The criteria that will be used to assess Technological Limitations will include:

- <u>Implementation</u> - Implementation describes the ease with which a technology could be brought on-line in the offpost area. Considerations include the technical, logistic, and political complexity of implementation, and the time required to construct and become operational. Technologies which present unreasonable implementation problems may be inappropriate.
- <u>Operation and Maintenance (O&M)</u> - O&M involves the complexity, down-time and effort to maintain proper operation of a technology during its period of use. Technologies with low O&M requirements are considered preferable to those with high requirements if all other factors are equal. Unreasonable O&M requirements can render some technologies inappropriate.

Each screening will be sequential following the order of the criteria listed. Technologies that pass through the site screening will be carried forward. Likewise, technologies will be screened for compatibility with contaminant characteristics and remaining technologies will be screened for technological limitations.

As outlined in pertinent guidance documents, special consideration will be given to innovative technologies. They will be accepted if there is reasonable belief that they may offer a better solution to certain problems than other available options. Innovative technologies that have the potential to offer better treatment performance or implementability, fewer adverse impacts than other available approaches, or lower costs than demonstrated technologies will be carried through the screening process.

The result of the screening will be a list of applicable remedial technologies for the offpost area. The list of available technologies, the inventories of applicable technologies and the specific criteria used to screen the technologies will be included in the forthcoming Technology Inventory and Screening Report.

10.1.3 DATA NEEDS

As a result of the technology screening process, information gaps on various technologies, especially innovative technologies, will be identified, and recommendations will be made for acquiring the data. Literature search and vendor contact may be sufficient to fill these voids. However, laboratory or bench-scale treatability studies may be initiated to fill other information gaps. Recommendations for potential treatability tests will also be made at this stage. Collection of additional data will be conducted under future FS tasks and will be used in the development of alternatives.

10.2 ALTERNATIVES DEVELOPMENT AND SCREENING

Alternatives development and screening will generate a set of alternatives to remediate the offpost area. The alternatives will be evaluated by criteria and screened to reduce the number of alternatives carried forward to the detailed analysis. This process is not inconsistent with the NCP and EPA guidance documents and is illustrated by the flow diagram in Figure 10.2-1.

10.2.1 ALTERNATIVES DEVELOPMENT

Remedial alternatives representing a range of actions will be developed from the inventories of applicable technologies. Processes which are

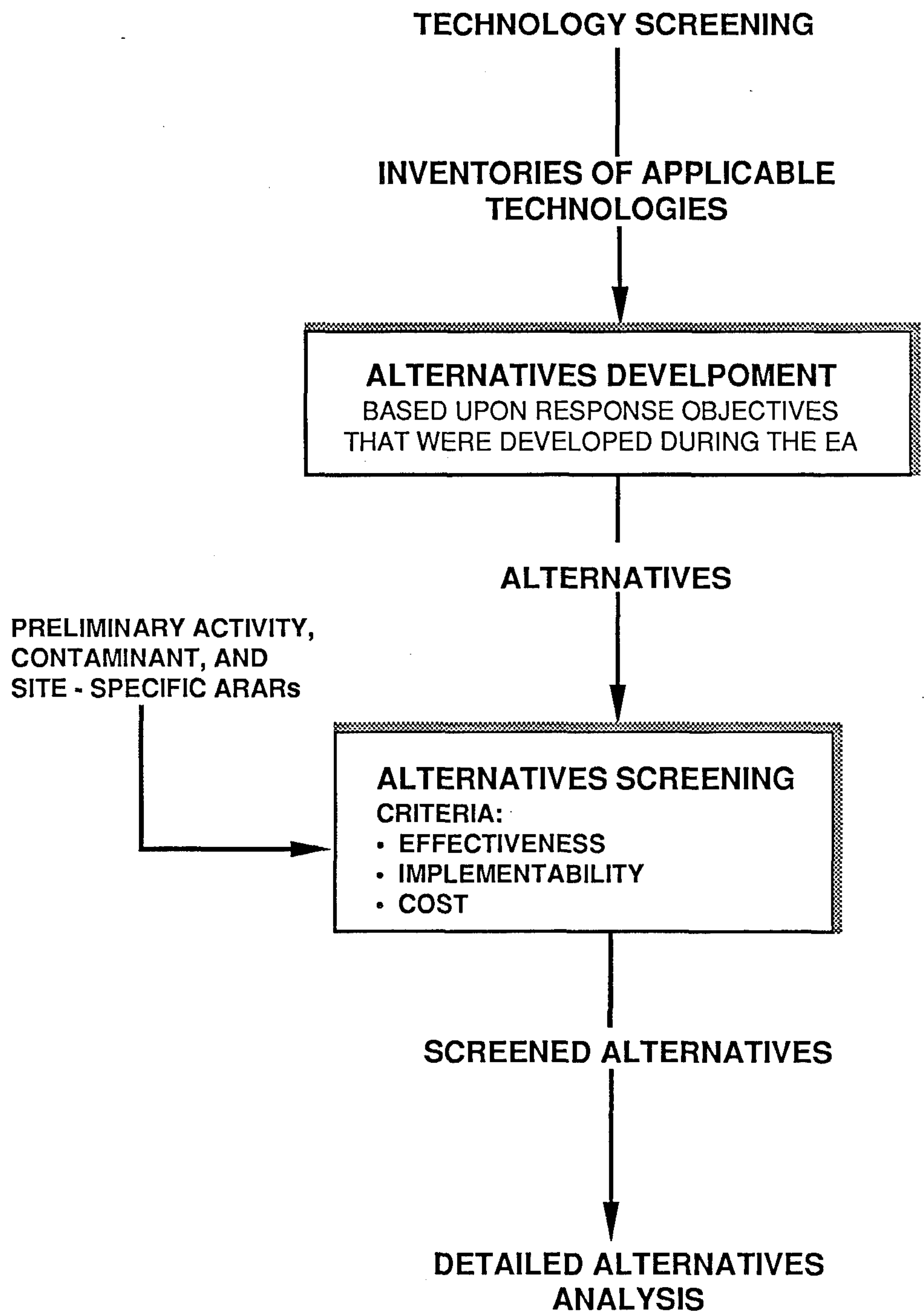

Figure 10.2-1
ALTERNATIVES DEVELOPMENT AND SCREENING
SOURCE: ESE,1988.

Prepared for:
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representative of a technology may be used in the alternatives development in order to obtain the required information for evaluation. The selected representative process will be the most viable process available for the alternative.

Remedial alternatives will span the range from "no action" to "no further action required after remediation". The alternatives will also be developed to meet the intent of response objectives which will be defined by input from the RI, EA, and ARARs. Response objectives will establish specific goals to be met in remediation of each of the media offpost of RMA. The response objectives will consider the exposure pathways and risks as well as available criteria, standards, or limitations contained within ARARs or health-based criteria. An example of a response objective is: the protection of humans from contact with water containing a contaminant above the health-based criteria determined for that pathway.

For each alternative, the following information will be provided:

- A description of the technologies that comprise the alternative;
- The volume or area of material that would be remediated;
- Approximate location of remedial action, disposal, or treatment systems;
- The contaminant and activity specific ARARs associated with the alternatives; and
- A description of how the alternative will be implemented.

The alternatives development as described here is not inconsistent with SARA and interim guidance documents. The alternatives will provide a range of remedial actions that will address the desired response objectives.

10.2.2 ALTERNATIVES SCREENING

After the alternatives have been developed, they will be evaluated and screened in order to reduce the number of alternatives to be carried through to the detailed analysis. However, in accordance with the NCP, a range of

alternatives, from no action to complete treatment eliminating long-term monitoring, will be preserved.

The criteria that will be employed in the screen will include effectiveness, implementability, and cost as described here:

- <u>Effectiveness</u> - Effectiveness considers the ability of the alternative to reduce the mobility, toxicity, or volume of the contamination as well as the ability to meet the response objectives. Additionally, effectiveness relates to an alternative's ability to protect human health and the environment.
- <u>Implementability</u> - The technical and administrative feasibility as well as availability of an alternative will be considered in the implementability criteria. The reliability of an alternative to meet associated performance requirements as well as continued control of contamination following remediation will also be considered.
- <u>Cost</u> - Cost analysis will be used to eliminate alternatives which are at least an order of magnitude more costly than other alternatives which provide similar results. Cost will not be used to compare alternatives that utilize a different type of remediation (i.e. treatment vs. disposal). The degree of cost estimation accuracy for this screen should be within a +50 percent to a -30 percent range, if practicable. Present-worth analysis will be used to evaluate expenditures that occur over different time periods.

Alternatives that use innovative technologies will be carried through the screening process if they offer a potential for better treatment performance or implementability, less cost, or few or less adverse impacts than other available alternatives.

The screen for each of the criteria will be independent, and failure to pass one or more screens may not be cause for elimination of an alternative from

further consideration. Engineering judgement will be used to evaluate and eliminate inappropriate alternatives.

10.2.3 DATA NEEDS

The alternative screening process will identify areas where additional site or technology performance data are required in order to further develop and evaluate alternatives. The data needs will be identified and recommendations will be made for acquiring the information. Means for collecting additional data may include:

- Treatability studies on specific technologies to demonstrate performance and to prepare more reasonable cost estimates in the detailed analysis of alternatives;
- Treatability studies on innovative technologies; and
- Additional site investigations in order to better define site and contaminant conditions.

Collection of additional data will be conducted under future FS tasks.

10.3 DETAILED ALTERNATIVES ANALYSIS

A detailed alternatives analysis will be conducted on the screened alternatives passing the previous screening step. The analysis will evaluate all the screened alternatives in detail against a set of criteria. This process is illustrated in Figure 10.3-1.

10.3.1 DETAILED ALTERNATIVES ANALYSIS

Alternatives that pass the previous screening step will be analyzed in detail and evaluated against a set of criteria. The results of this detailed evaluation will be a group of alternatives which show the greatest potential for remediation of the offpost area and which satisfy the response objectives. A detailed analysis of each alternative will be performed to provide the supporting documentation as needed to select the preferred alternatives and to prepare and finalize the ROD.

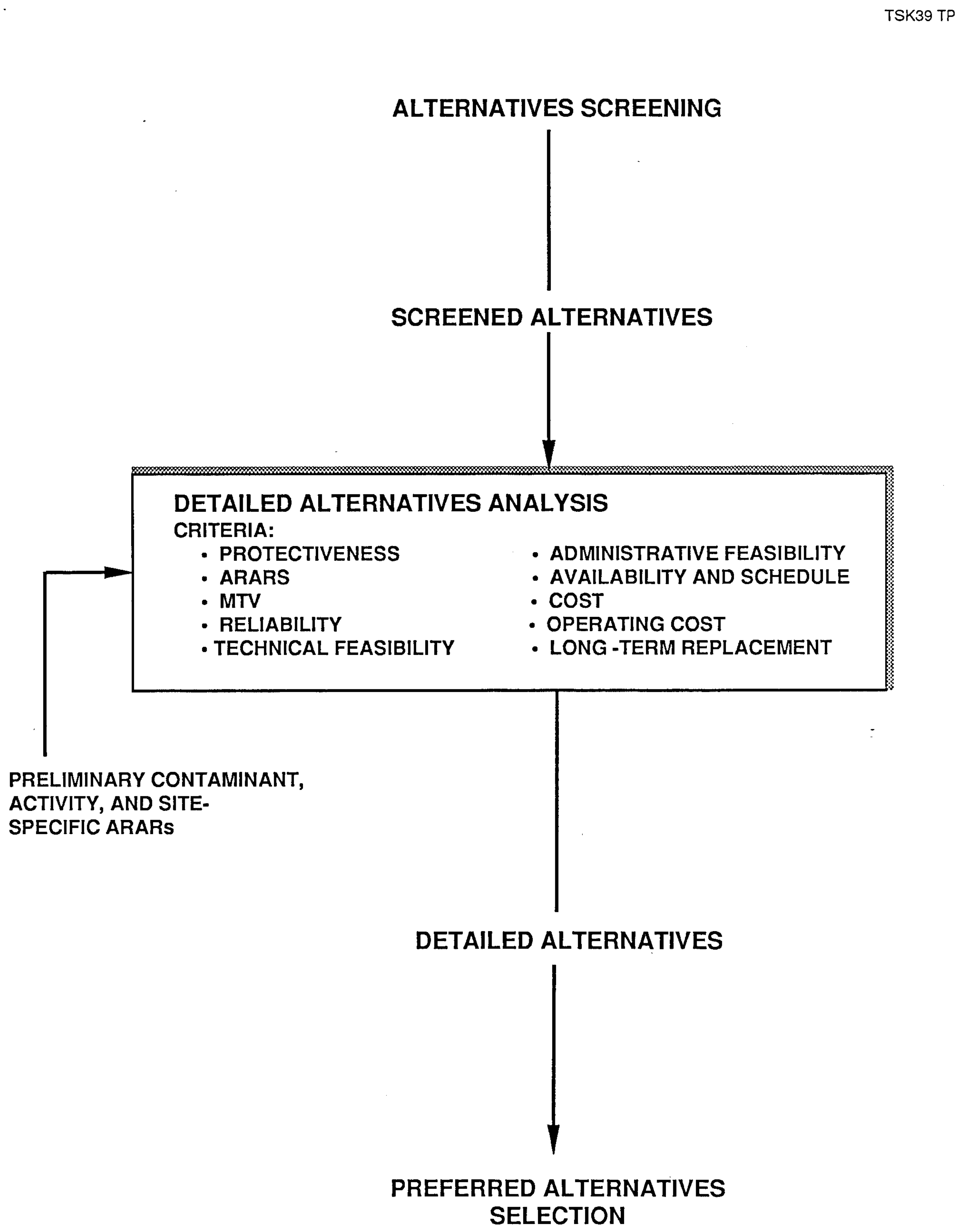

Figure 10.3-1
DETAILED ALTERNATIVES ANALYSIS

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Each remedial action alternative will be evaluated independently for long- and short-term effectiveness, implementability, and costs. These three criteria will be further divided into ten criteria which address all considerations within the interim guidance (EPA, 1986a). Following the analysis of the alternatives against each of the individual criteria, the alternatives will be assessed as to how well they are protective of human health and the environment.

Effectiveness will be divided into three criteria including protectiveness, compliance with ARARs, and reduction of mobility, toxicity, or volume. Each of these criteria are described below:

- <u>Protectiveness</u> - This criterion involves a determination of whether the alternative provides the degree of removal or treatment necessary to reduce exposure to or migration of contamination to levels which adequately protect human health and the environment. The ability of the alternative to maintain long-term protectiveness, the time required to reach the required level of protection, and the protection afforded workers during remediation will be considered.
- <u>Compliance with ARARs</u> - This factor evaluates the ability of a given alternative to meet the substantive requirements of ARARs. This includes ARARs associated with the contaminants, the site, or the specific activity. In cases where an ARAR will not be met, reasons for such determination, including a technical justification for a waiver, will be provided consistent with EPA guidance. At this stage of the alternatives analysis, only preliminary ARARs may be available. As ARARs are finalized, they will be applied to the remaining alternatives.
- <u>Reduction of Mobility, Toxicity, or Volume</u> - Although an alternative may be protective and meets ARARs, SARA further requires an evaluation of the alternative for ability to reduce the toxicity, mobility, or volume of contaminants. This factor reflects the SARA preference for permanent destruction or isolation of contaminants, thus eliminating potential future

threats to the environment. Therefore, removal/treatment alternatives are considered preferable to containment, particularly landfilling of untreated, unstabilized hazardous wastes.

Implementability will be subdivided into reliability, technical feasibility, administrative feasibility, and availability and schedule. These criteria are described as follows:

- Reliability - Factors considered in assessing reliability are the ability of an alternative to deliver and maintain an adequate level of performance. This includes assessment of the potential need for replacement and the consequences of failure of the original action.
- Technical Feasibility - This factor considers the ability of the alternative to be constructed or implemented for the specific site and provide the required level of protection. This includes evaluation of site or technological limitations that have been identified or should be further considered as possible limitations to performance.
- Administrative Feasibility - Administrative factors may significantly affect the viability of a certain remedy. State and community acceptance is a factor that may impact selection and implementation of a remedial action and should be identified and considered.
- Availability and Schedule - Although an alternative may meet all other criteria, the system size or required level of development may limit availability. The time required to design and construct suitable equipment will be compared against the time required to remediate using other technologies.

The cost criteria will include construction and developmental costs, operating costs, and long-term replacement. These items are described below:

- Construction and Developmental Costs - Capital cost will be developed on a unit cost basis considering all elements of the alternative. Investigative, developmental, or design costs necessary to implement the alternative will be considered. In accordance with SARA, capital costs will also include the first 10 years of operating and maintenance costs.
- Operating Costs - This factor includes all labor, materials, and utility costs necessary to operate the system and maintain the desired level of protection. Operation and maintenance includes the replacement costs for materials with a limited lifetime. Also included is the cost for monitoring and/or reinvestigating areas where complete removal or destruction is not performed.
- Long-Term Replacement Costs - In cases where complete removal or destruction is not provided, replacement of containment systems may be required following failure or at the end of the systems design life. Capital and operating costs for such replacement will be included in evaluation of the original system.

Present worth will be calculated for a 30-year period reflecting capital costs, operating costs, and long-term replacement costs.

Alternatives will be evaluated as a composite group of technologies and not individual technologies or processes. However, in order to determine the protectiveness and cost of an alternative it will be necessary to calculate performance and cost data for each technology. Once again, selection of a representative process within a technology may be necessary to calculate this information. As previously stated, the most viable process will be chosen to represent a technology. The overall cost of the alternative will be a summation of the cost for individual technologies or processes.

10.3.2 DATA NEEDS

From the alternatives analysis, additional data needs will be identified to complete the analysis and to support the detailed alternatives that will be carried through to the preferred alternatives selection. These data needs may be similar to those identified at the end of the screening of alternatives, however the focus will be concentrated on addressing specific alternatives and the scope of the resulting efforts may be significantly more detailed. Specific needs which will be identified during or at completion of the detailed alternatives analysis will likely be obtained by pilot studies and modeling. Recommendations for collection of data will be made and the information will be gathered as part of the FS program.

10.4 PREFERRED ALTERNATIVES SELECTION

The selection of the preferred alternatives will be done in accordance with the requirements set forth in CERCLA and SARA and will not be inconsistent with the NCP or EPA guidance that is not inconsistent with CERCLA, SARA, and the NCP. The preferred alternative selection process is represented in Figure 10.4-1. The EPA (1986a) Interim Guidance on Superfund Selection of Remedy proposes that the selected remedy or preferred alternative meet the following four criteria:

- o Remedies must be protective of human health and the environment. This means that the remedy meets or exceeds ARARs or health-based levels established through a risk assessment when ARARs do not exist.
- o Remedies should attain Federal and State public health and environmental requirements that have been identified for a specific site. In general, the remedy selection process presumes that alternatives will be formulated and refined to ensure that they attain all of the appropriate ARARs. However, SARA provides waivers which permit selection of remedies which do not attain all ARARs under the following six circumstances: fund-balancing, technical impracticability, interim remedy, greater risk to health and the environment, equivalent standard of performance, and inconsistent application of State standards. If a remedy is

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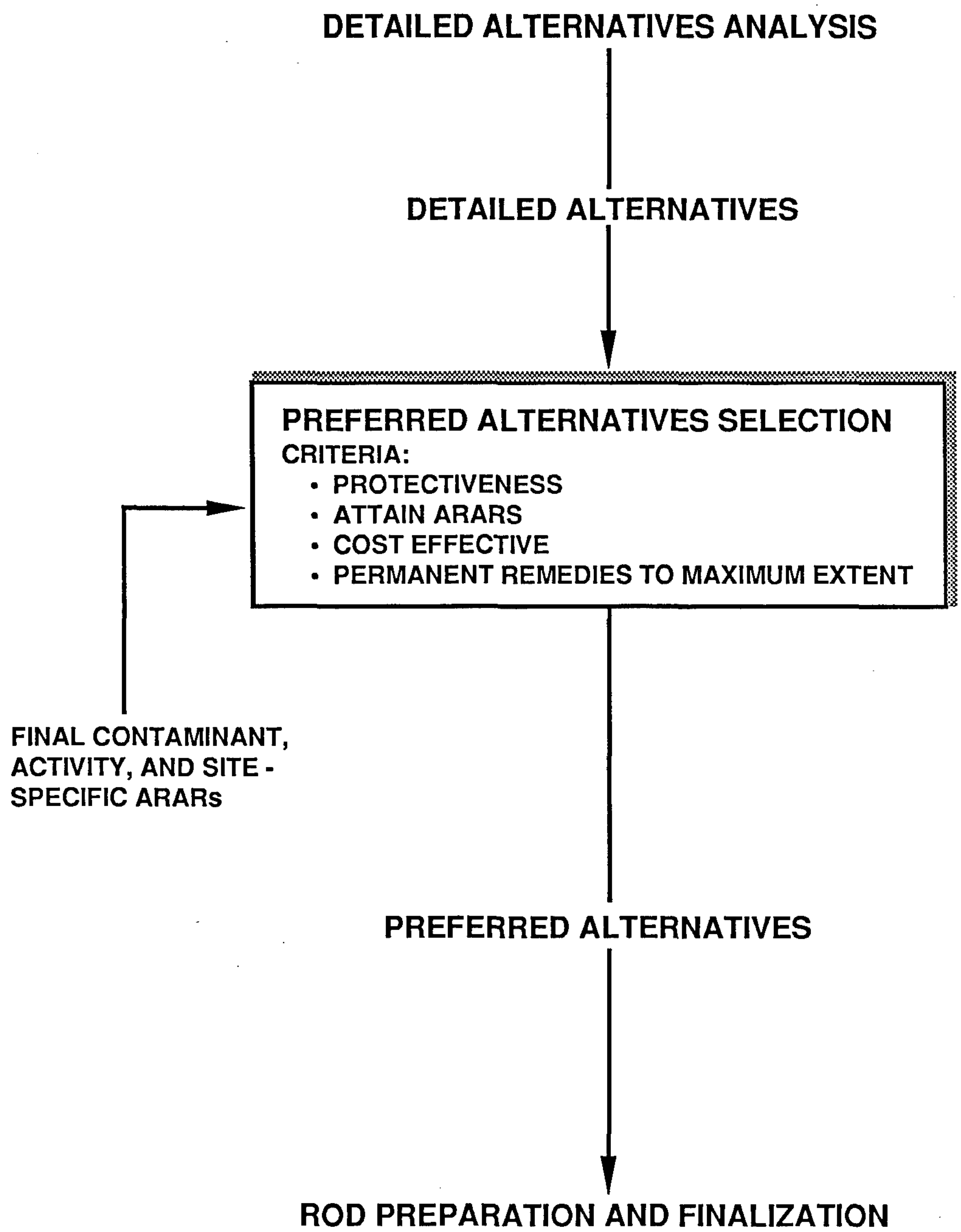

Figure 10.4-1
PREFERRED ALTERNATIVES SELECTION

SOURCE; ESE,1988.

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protective, cost-effective, and adequately satisfies the satutory preferences, inability to attain a particular ARAR will not necessarily prevent selection of that alternative if it was viewed as the all around best remedial alternative.

- Remedies must be cost-effective. In general, this finding requires ensuring that the results of a particular alternative cannot be achieved by less costly methods. This implies that for any specific site there may be more than one cost-effective remedy, with each remedy varying in its environmental and public health results.
- Remedies must utilize permanent solutions and alternative treatment technologies or resource recovery technologies to the maximum extent practicable. This determination is interrelated to the cost-effectiveness finding and includes consideration of technological feasibility and availability.

Preferred alternatives will be selected and will represent the best balance across all the effectiveness, implementability, and cost factors examined in the detailed analysis. The selection of preferred alternatives will consider the statutory preference for treatment which permanently and significantly reduces the toxicity, mobility, or volume of the waste.

10.5 FS PRODUCTS/ROD PREPARATION AND FINALIZATION

The FS efforts to develop preferred alternatives or remedies for the area offpost of RMA will be documented in the preparation and finalization of the ROD, as shown in Figure 10.5-1. In order to document the FS efforts and to support the offpost ROD, an FS report will be prepared for the offpost area. The report will be consistent with EPA (1987) interim guidance for RODs and will contain all of the pertinent information relative to technologies and alternatives that were considered, and information regarding the screening and analysis processes. The reports will be prepared so as to be easily input to the ROD program. Specifically, the reports will contain:

- A statement and justification that the selected remedy is protective and cost-effective, attains ARARs, and uses to the

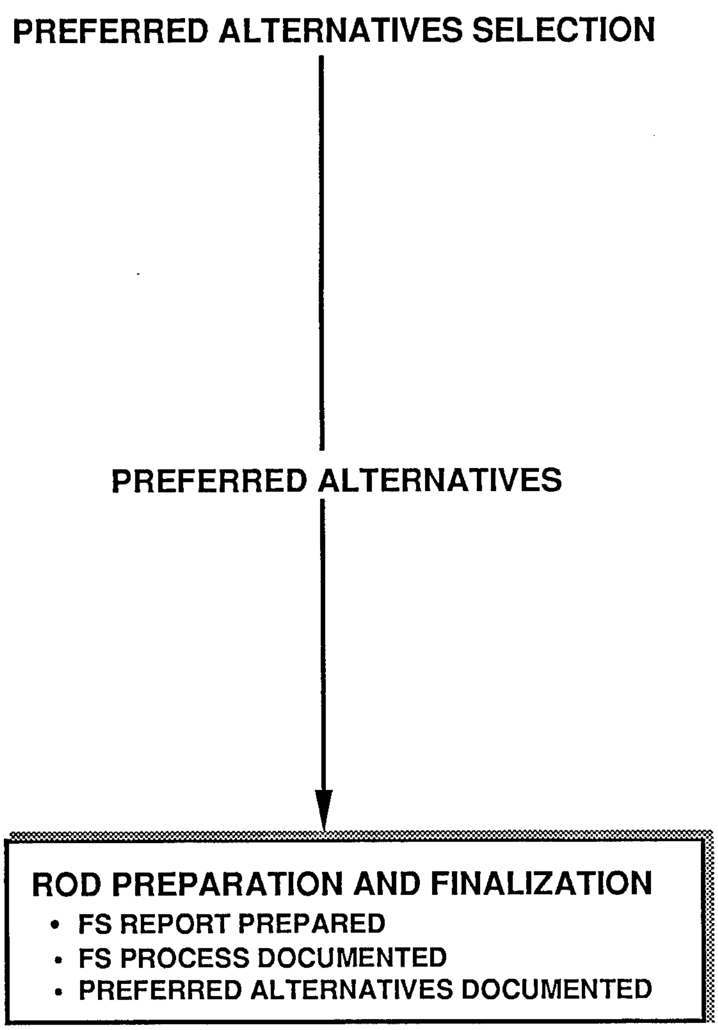

Figure 10.5-1
ROD PREPARATION AND FINALIZATION

SOURCE: ESE, 1988

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PART V - MANAGEMENT AND ADMININSTRATION
(SECTION 11.0)

11.0 MANAGEMENT AND ADMINISTRATION

ESE will devote sufficient project management, planning consultant, supervisory, administrative, and clerical staff to ensure maintenance of a smoothly operating program, without impact on previous or subsequent tasks. A Management Plan has been prepared in accordance with DD Form 1423, A003, that includes a Resource Utilization Plan for this task, and Cost and Performance Reporting consistent with requirements of Task 1. Computer-to-computer communications will be maintained as implemented in Task 1 (ESE, 1985a, RIC#85127R07).

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APPENDIX A
DISTRIBUTION OF OFFPOST CONTAMINANTS

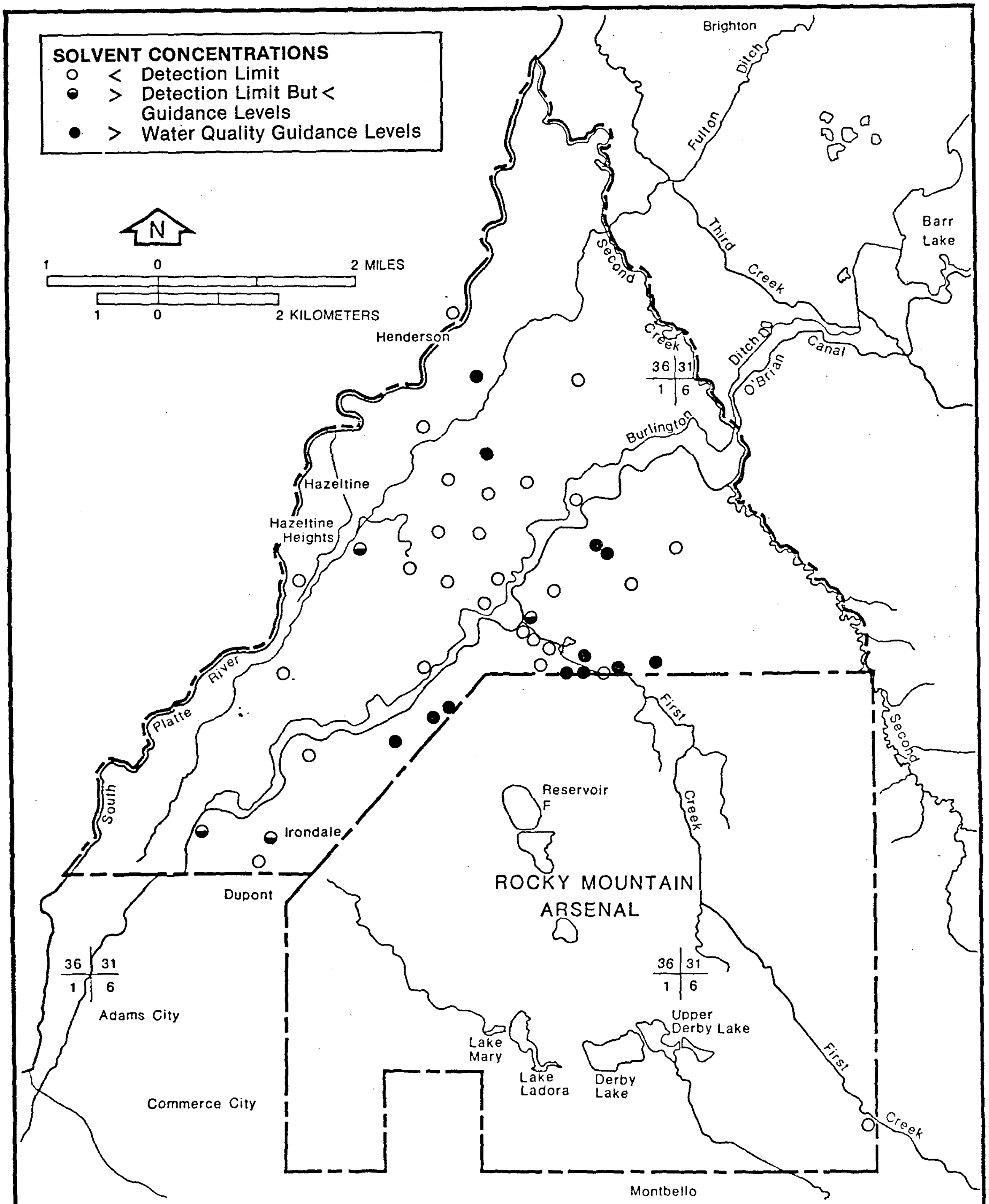


Figure A-1
AROMATIC AND HALOGENATED ALIPHATIC SOLVENT ASSESSMENT RMA OFFPOST FIRST QUARTER SAMPLING OF WELLS
SOURCE: ESE, 1987

Prepared for:
U.S. Army Program Manager's Office
For Rocky Mountain Arsenal
Aberdeen Proving Ground, Maryland

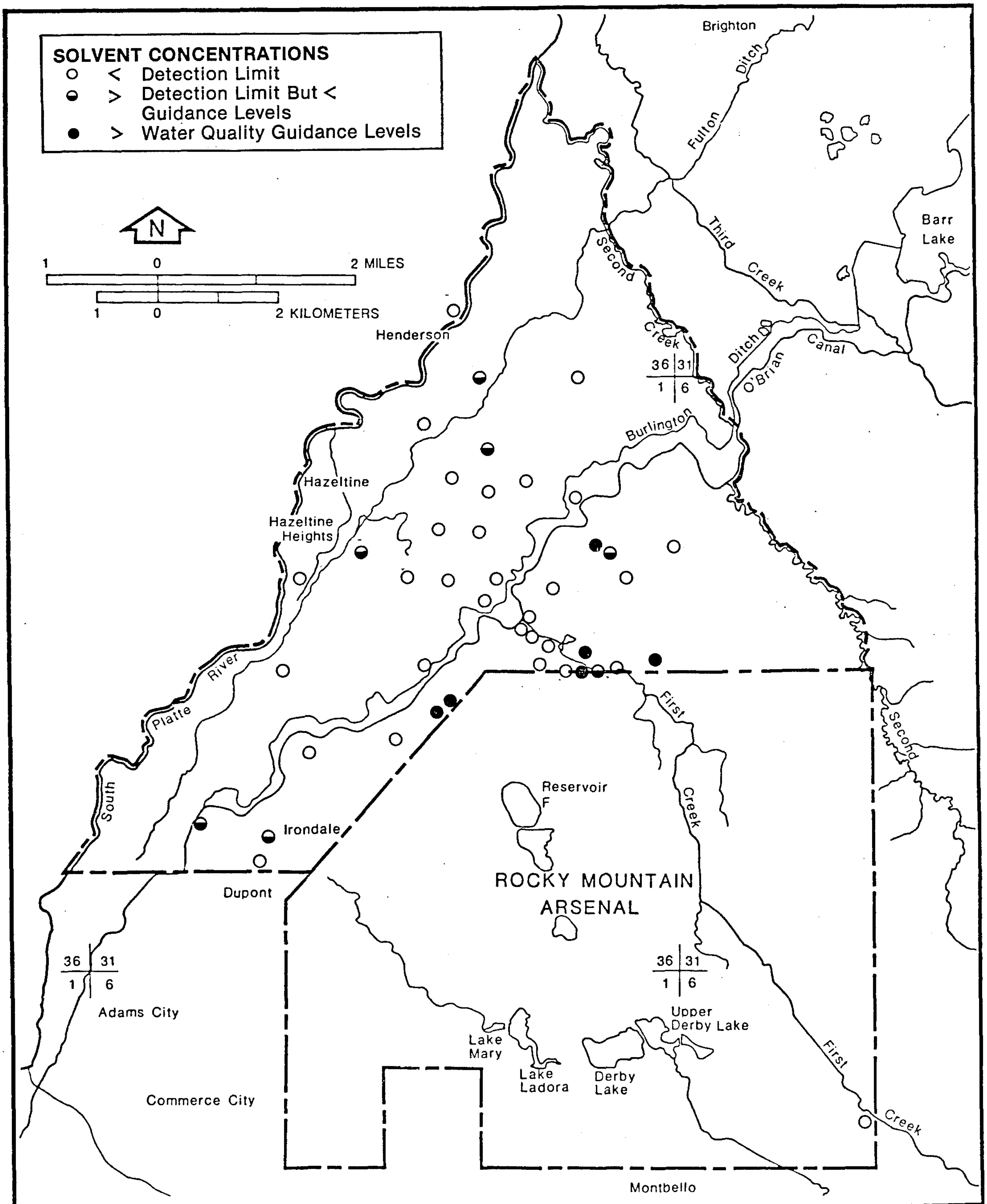


Figure A-2
AROMATIC AND HALOGENATED ALIPHATIC SOLVENT ASSESSMENT RMA OFFPOST SECOND QUARTER SAMPLING OF WELLS
SOURCE: ESE, 1987

Prepared for:
U.S. Army Program Manager's Office For Rocky Mountain Arsenal
Aberdeen Proving Ground, Maryland

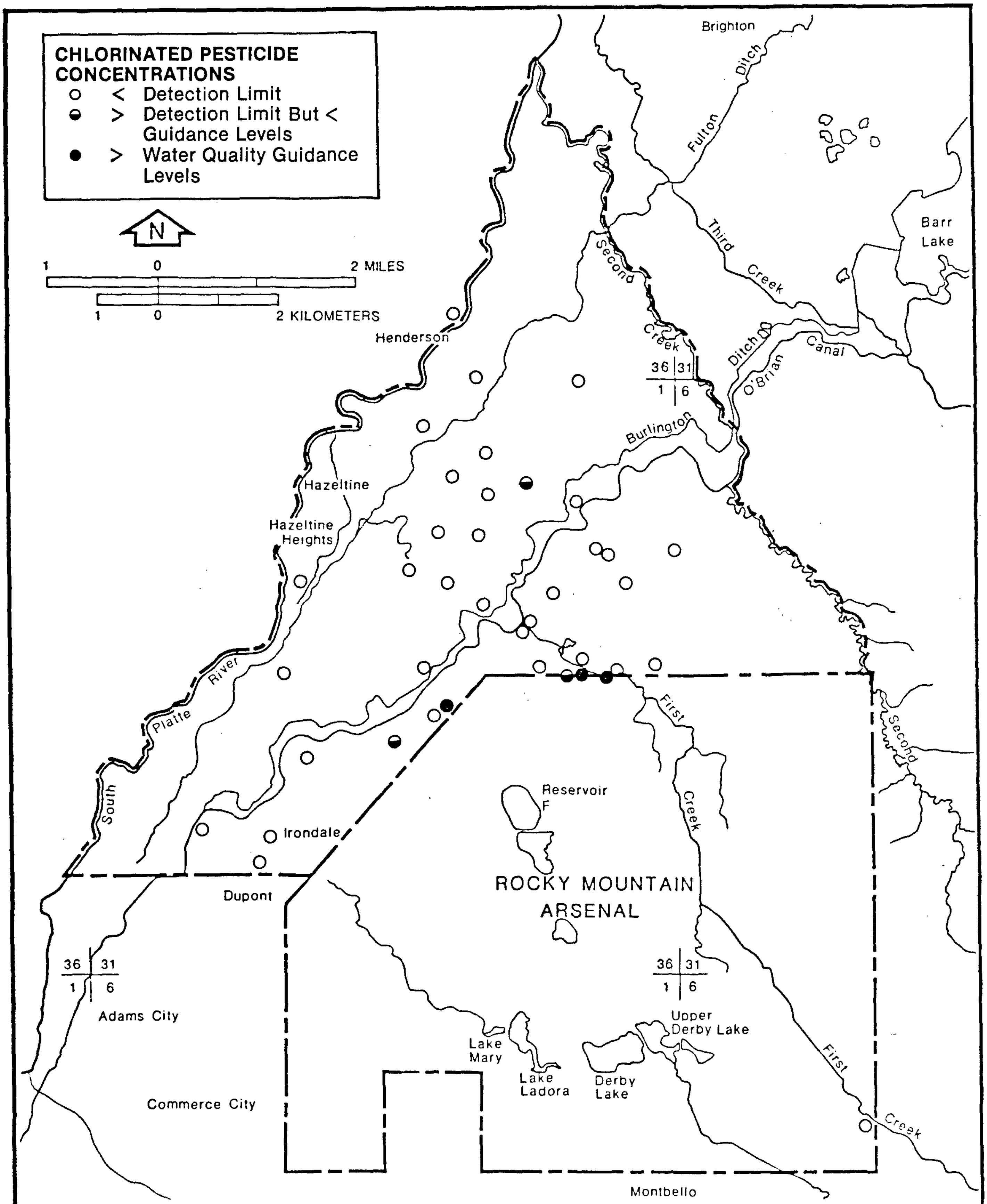


Figure A-3
CHLORINATED PESTICIDE ASSESSMENT
RMA OFFPOST FIRST QUARTER SAMPLING OF WELLS
SOURCE: ESE, 1987

Prepared for:
U.S. Army Program Manager's Office
For Rocky Mountain Arsenal
Aberdeen Proving Ground, Maryland

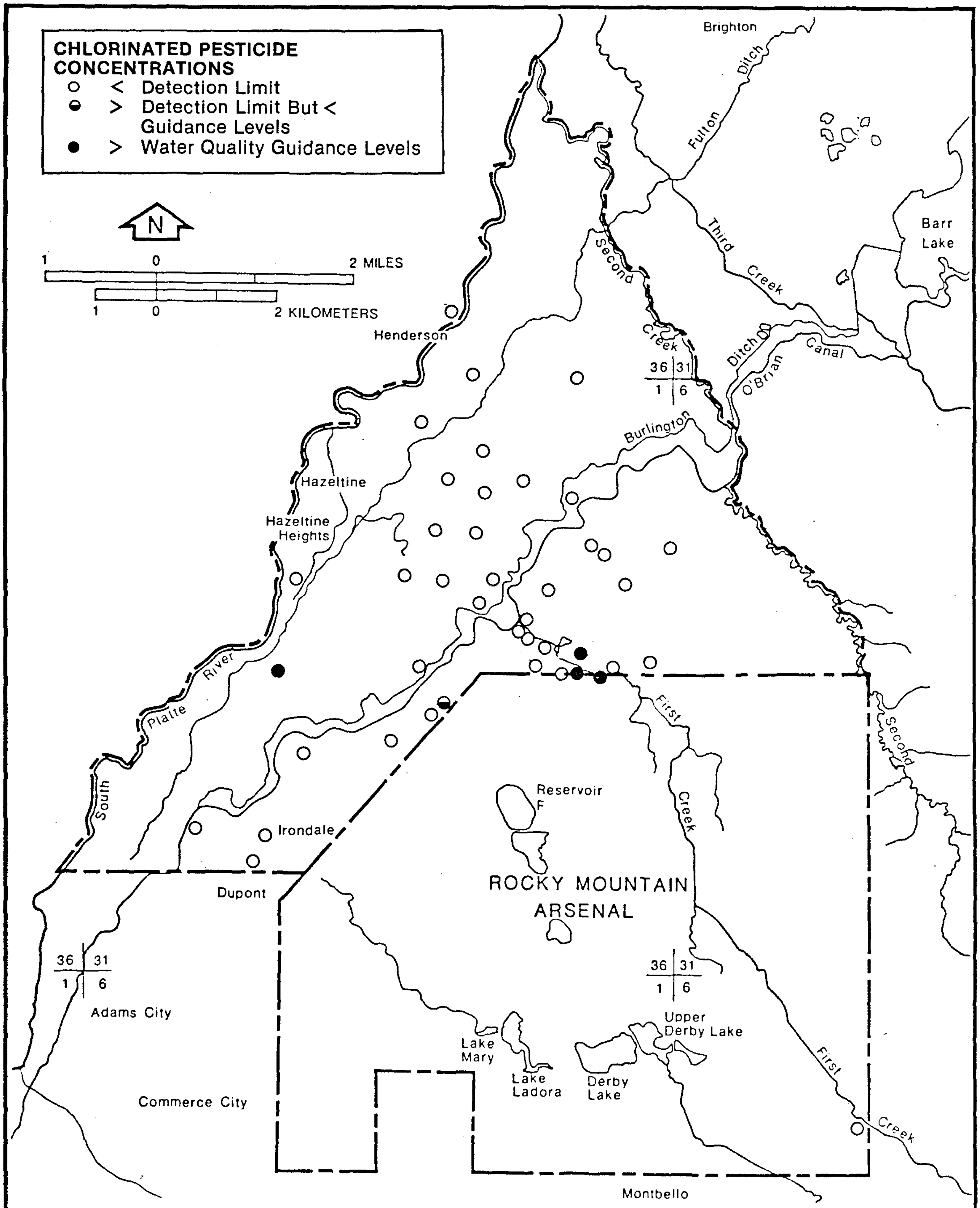


Figure A-4
CHLORINATED PESTICIDE ASSESSMENT
RMA OFFPOST SECOND QUARTER
SAMPLING OF WELLS
SOURCE: ESE, 1987

Prepared for:
U.S. Army Program Manager's Office
For Rocky Mountain Arsenal
Aberdeen Proving Ground, Maryland

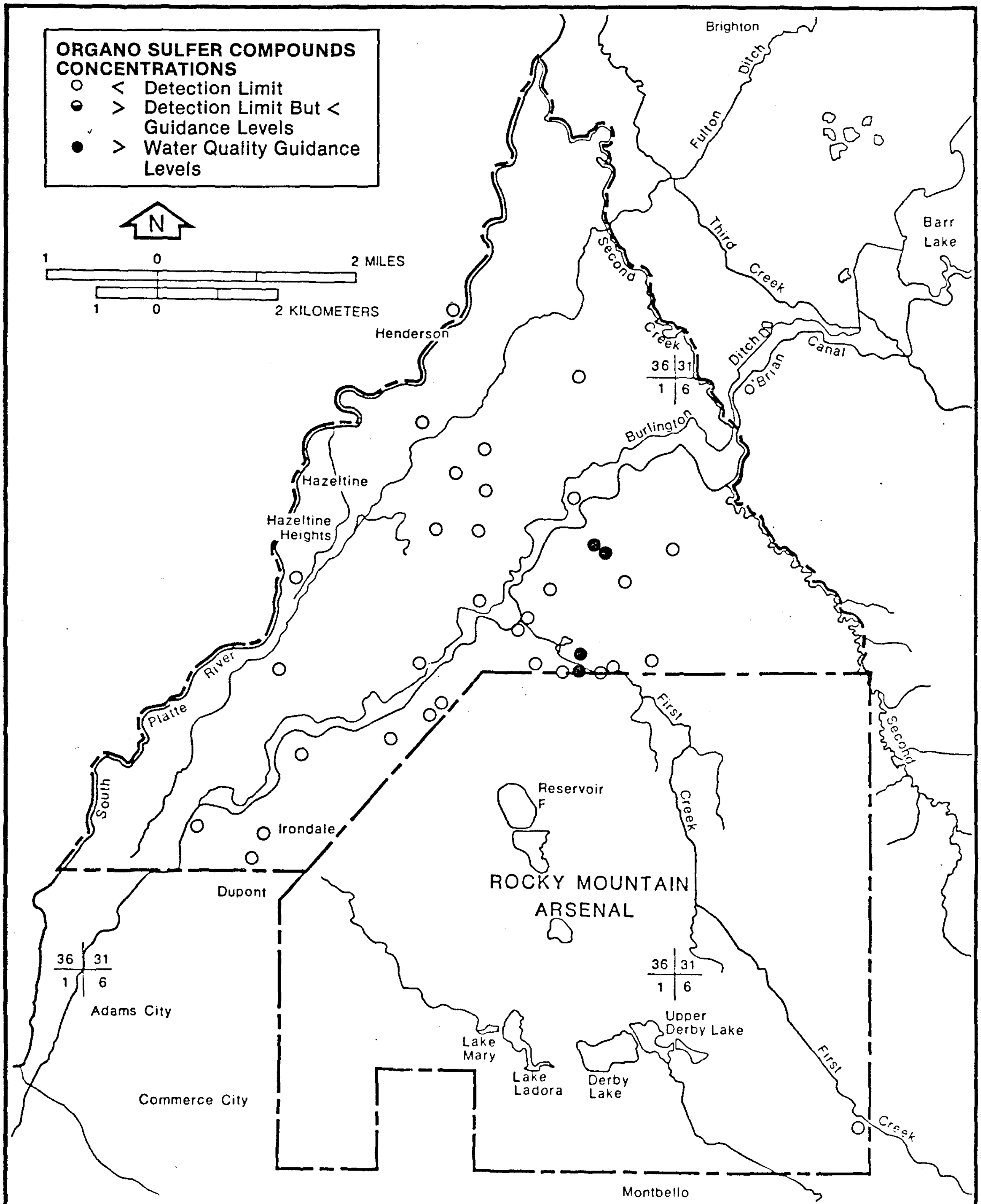


Figure A-5
ORGANOSULFUR COMPOUNDS ASSESSMENT RMA OFFPOST FIRST QUARTER SAMPLING OF WELLS
SOURCE: ESE, 1987

Prepared for:
U.S. Army Program Manager's Office For Rocky Mountain Arsenal
Aberdeen Proving Ground, Maryland

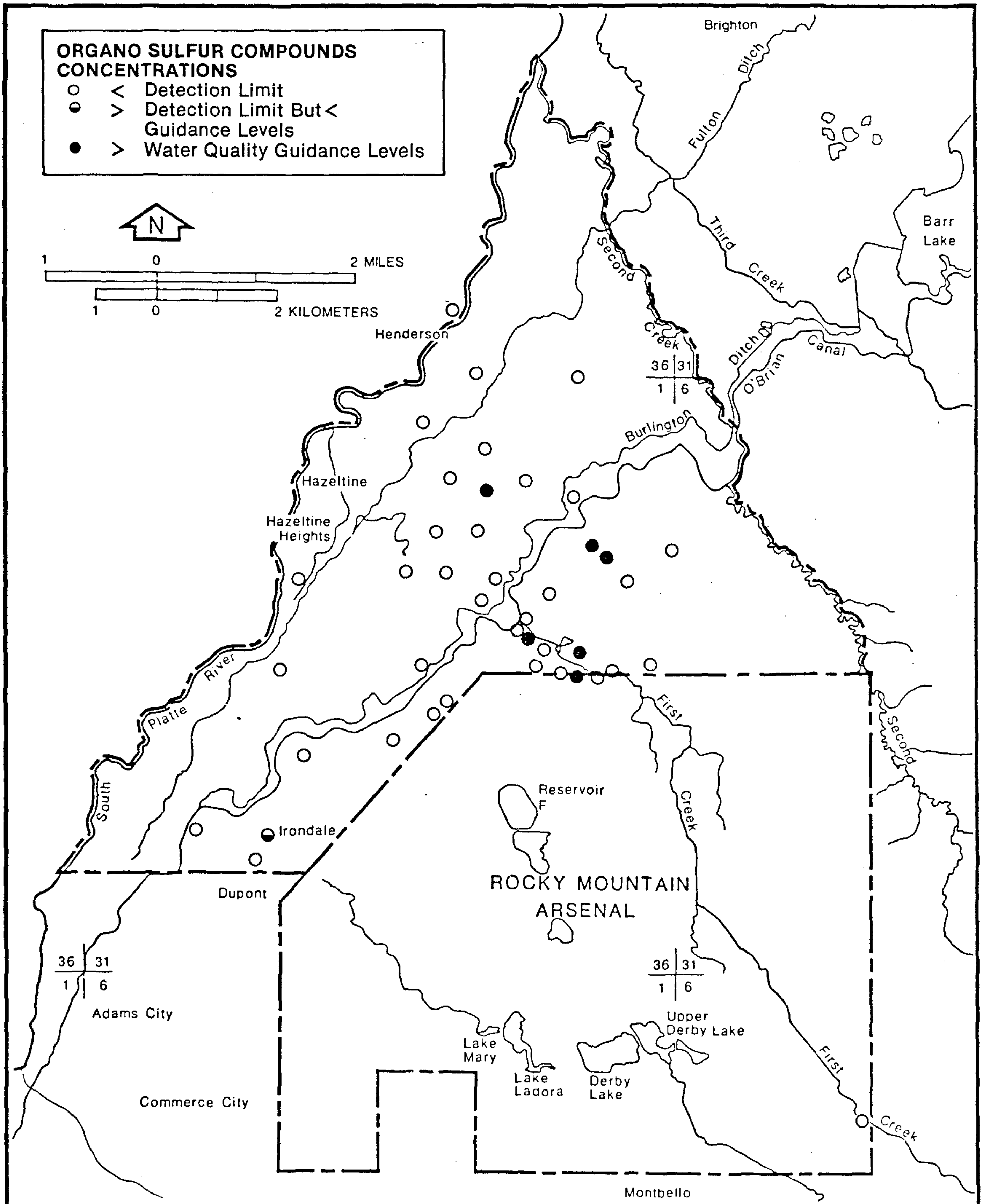


Figure A-6
ORGANOSULFUR COMPOUNDS ASSESSMENT RMA
OFFPOST SECOND QUARTER SAMPLING OF WELLS
SOURCE: ESE, 1987

Prepared for:
U.S. Army Program Manager's Office
For Rocky Mountain Arsenal
Aberdeen Proving Ground, Maryland

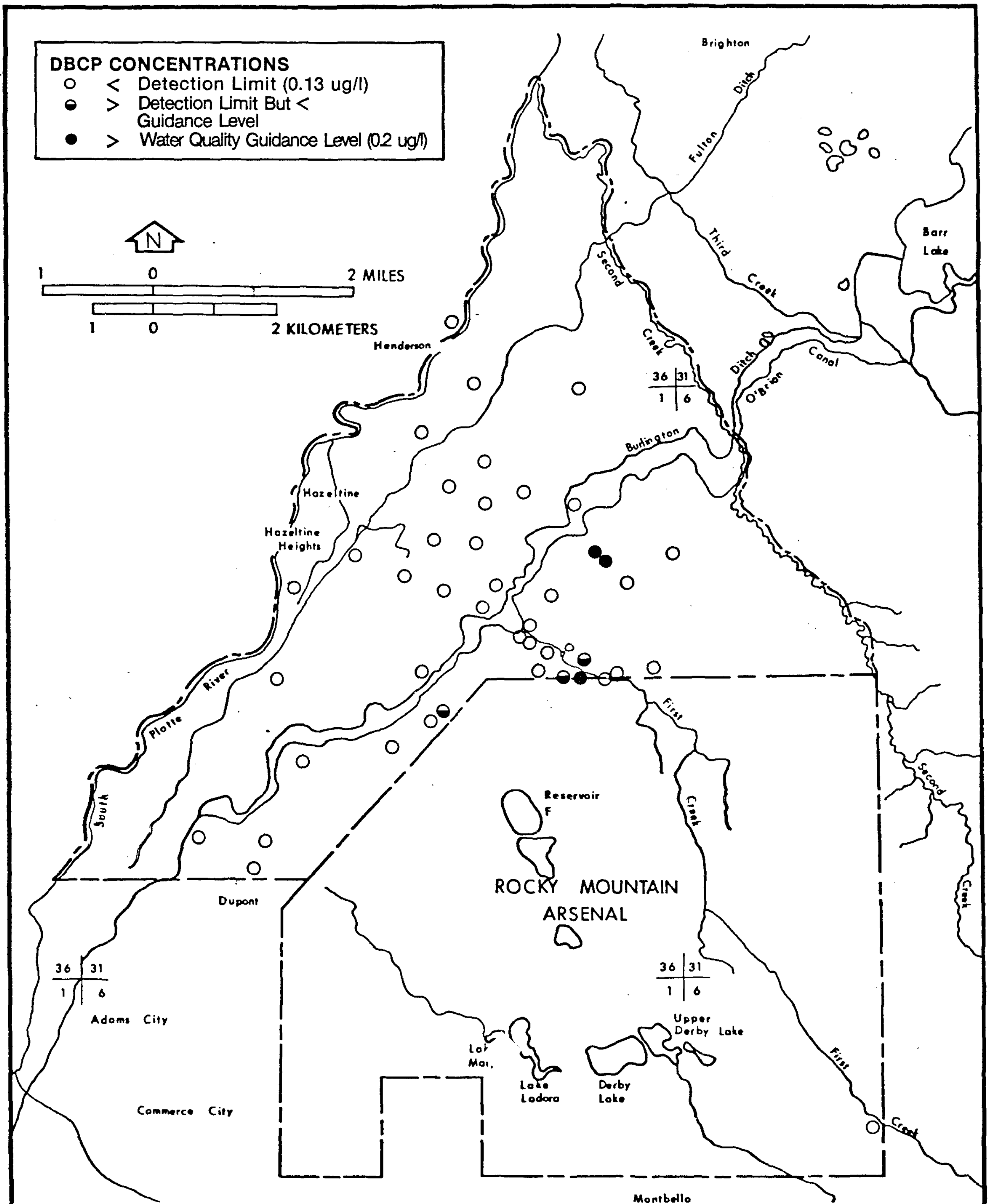


Figure A-7
DBCP ASSESSMENT RMA OFFPOST FIRST QUARTER SAMPLING OF WELLS
SOURCE: ESE, 1987

Prepared for:
U.S. Army Program Manager's Office For Rocky Mountain Arsenal
Aberdeen Proving Ground, Maryland

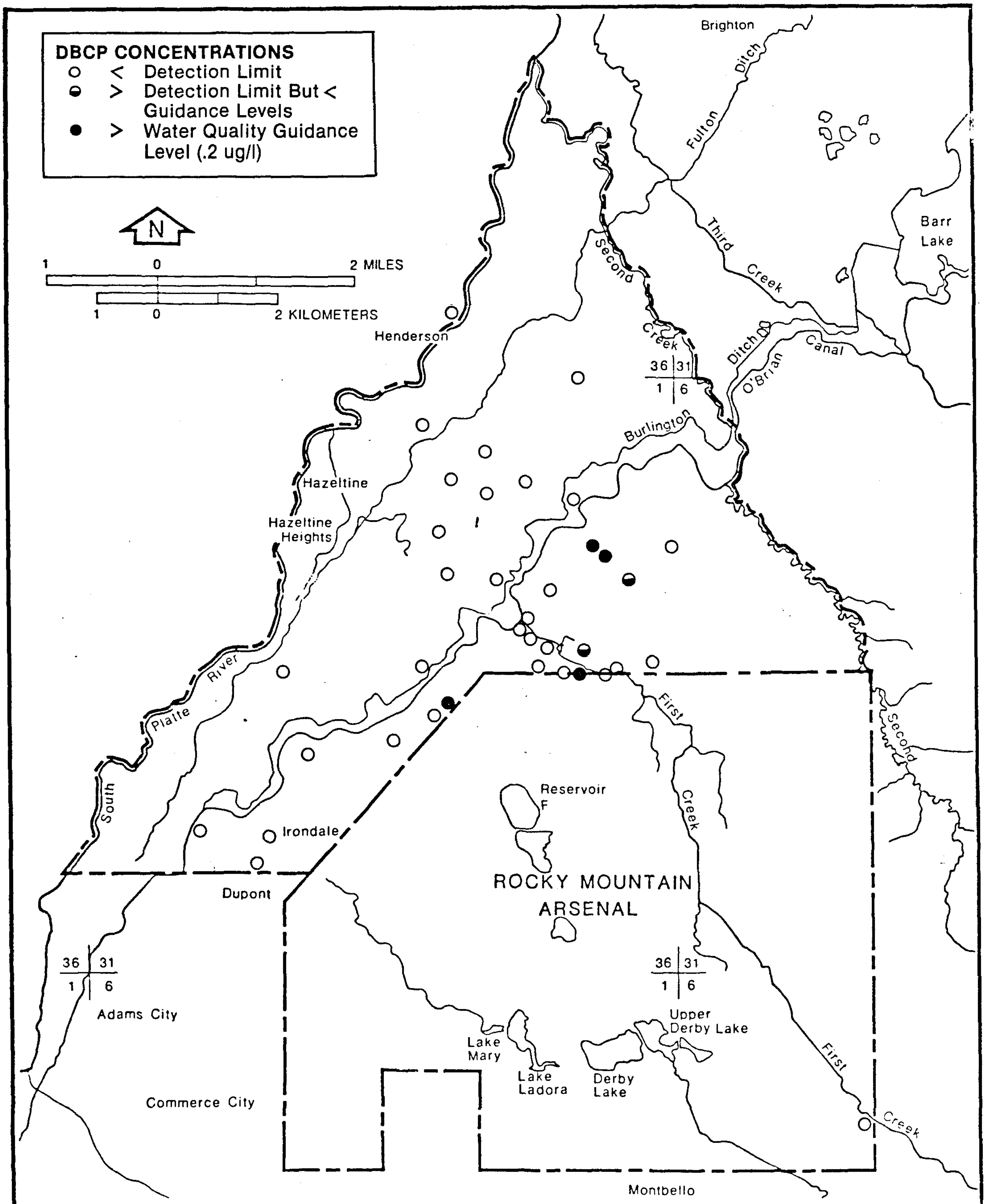


Figure A-8
DBCP ASSESSMENT RMA OFFPOST
SECOND QUARTER SAMPLING OF WELLS
SOURCE: ESE, 1987

Prepared for:
U.S. Army Program Manager's Office
For Rocky Mountain Arsenal
Aberdeen Proving Ground, Maryland

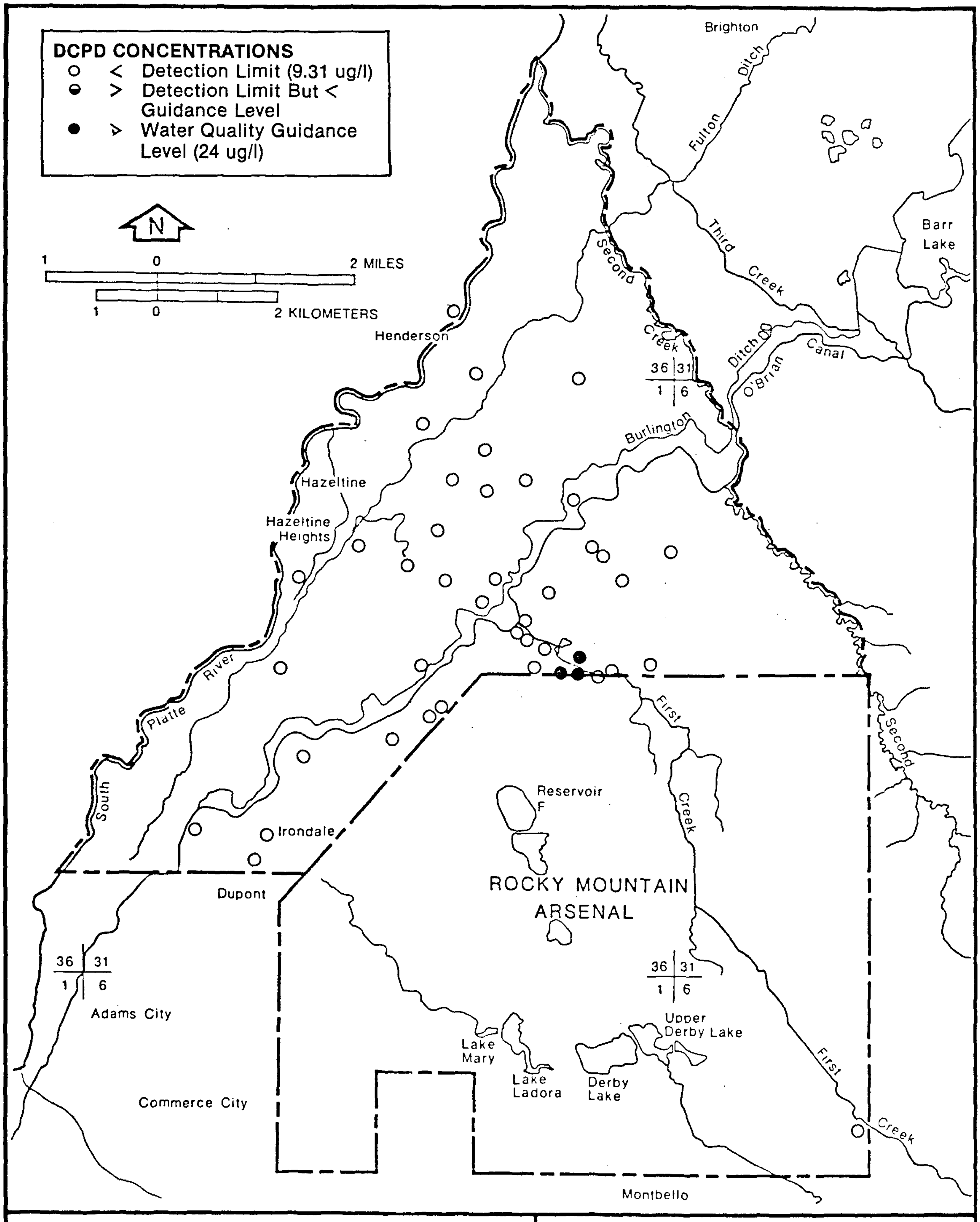


Figure A-9
DCPD ASSESSMENT RMA OFFPOST FIRST QUARTER SAMPLING OF WELLS
SOURCE: ESE, 1987

Prepared for:
U.S. Army Program Manager's Office For Rocky Mountain Arsenal
Aberdeen Proving Ground, Maryland

APPENDIX B
LETTER TECHNICAL PLANS FOR
OFFPOST GEOTECHNICAL PROGRAM

August 14, 1986

Project No. 86942, 86946, and Task 36

Letter Technical Plan

RE: Combined Offpost Borehole and Monitor Well Drilling Program
Task 25, 36, and 39

ESE, Inc. has prepared a comprehensive drilling program incorporating elements of the borehole/corehole and monitor well drilling programs of Tasks 25, 36, and 39. This proposed Offpost drilling program was prepared by a committee composed of ESE's hydrogeologist, geochemists, geologists, and engineers involved in each of these tasks. Also, comments and recommendations made by Brian Anderson of the RMA-PMO, James May of the Corps of Engineers, and yourself have been considered and incorporated into the proposed drilling program.

Briefly, the proposed drilling program is designed to be flexible yet still provide adequate geologic ground water and geochemical information.

The location of well sites, the number of wells per site, and completion intervals for each well are not rigidly fixed at this point. Well sites which appear on the enclosed map, Attachment A, represent the general location where data is needed and where physical access is best. The precise location of wells will depend on the U.S. Army Corps of Engineers obtaining right of entries, access ways and right-of-ways, and results of the geophysics and borehole/corehole drilling.

The boreholes/coreholes and monitoring wells will be completed in both the alluvial material and the sandstones of the Denver Formation. Cluster well sites will consist of one alluvial well paired with one or two Denver Formation wells. At sites with 2 Denver wells, the wells will

be completed within the first and second sandstone aquifers encountered during drilling.

The installation of Denver Formation monitoring wells will be concentrated within an area 1½ miles north of the arsenal and west of Potomac Street to Colorado Route 2. The Denver wells are concentrated in this area since this area is where the Denver sandstones which subcrop under RMA also subcrop in the Offpost.

Enclosed are copies of the following materials:

1) Map titled "Proposed Well and Boring Sites with Locations of Existing Wells", Attachment A;

2) Table titled "Proposed Activities at Drill Sites", Attachment B; and

3) Site descriptions.

Prepared by,

Roy L. Cox/MEM

Roy L. Cox
CPGS #6556

ATTACHMENT B
PROPOSED ACTIVITIES AT DRILL SITES

[redacted]tta[redacted]nt [redacted] '[redacted]pose[redacted]cti[redacted]es [redacted]ril[redacted]tes[redacted] COMPL[redacted]ON DATA [redacted]

ESE Site	Quarter/ Quarter Section Location	*Owner	Existing Well	Geophysics Line	Proposed Number of Wells	Alluvial Well	Intermediate Denver Well	Lower Denver Well
E-32	NW/4 NW/4-24	RMA	24093(A11)	No	2	---	yes	yes
-33	NW/4 NW/4-24	RMA	24163(A11)	No	2	---	yes	yes
-34	SE/4 SW/4-13	A	37338(A11)	No	2	---	yes	yes
-35	NE/4 NE/4-24	RMA	-	No	bore only	---	---	---
-36	SE/4 SE/4-13	A	-	yes	3	yes	yes	yes
-37	SE/4 SE/4-15	A	-	yes	3	yes	yes	yes
-38	SW/4 SW/4-14	S	-	yes	(2-3)	may be dry	yes	yes
-39	SE/4 SW/4-14	P	-	yes	3	yes	yes	yes
-40	SW/4 SE/4-14	P	37305	No	2	---	yes	yes
-41	SE/4 SE/4-14	P	37304	No	2	---	yes	yes
-42	SE/4 SE/4-14	P	-	No	3	yes	yes	yes
-43	NE/4 SW/4-14	P	-	yes	bore only	---	---	---
-44	NW/4 SE/4-13	P	-	yes	3	yes	yes	yes
-45	NW/4 SW/4-13	A	37323	yes	2-3	?	yes	yes
-46	NW/4 SW/4-13	P	-	yes	3	yes	yes	yes
-47	NE/4 SW/4-13	P	-	yes	3	yes	yes	yes
-48	NW/4 SE/4-13	P	-	yes	bore only	---	---	---
-49	NW/4 SW/4-18	A	37327	No	2	---	yes	yes
-50	SW/4 NE/4-14	S	-	yes	1	yes	---	---
-51	NW/4 NE/4-14	S	37342	yes	2	---	yes	yes
-52	SE/4 SE/4-11	A	-	yes	1	yes	---	---
-53	SW/4 SE/4-12	A	-	yes	3	yes	yes	yes
-54	SW/4 SE/4-12	A	-	yes	3	yes	yes	yes
-55	NE/4 SW/4-22	A?/P?	-	yes	1	yes	---	---
-56	NE/4 SE/4-15	P	-	yes	1	yes	---	---
-57	SW/4 SE/4-11	S	-	yes	1	yes	---	---
-58	NE/4 SE/4-11	A	-	yes	1	yes	---	---
-59	SE/4 NW/4-12	S	-	yes	1	yes	---	---
-60	SW/4 NW/4-15	UP/ RR	-	yes	1	yes	---	---
-61	SW/4 SW/4-11	A	-	---	1	yes	---	---
-62	SE/4 NW/4-11	P	-	yes	1	yes	---	---
-63	SW/4 SW/4-13	P	-	yes	3	yes	yes	yes
-64	NW/4 NW/4-13	A	-	yes	3	yes	yes	yes

*Owner Code

P=Private Owner S=State Hwy. Dept. RMA=Rocky Mountain Arsenal

A=Adams County Hwy. Dept UP/RR=Union Pacific Railroad

ATTACHMENT C
SITE DESCRIPTIONS

INTRODUCTION

This is to request access to Colorado Department of Highways owned right-of-way along Highway 2 and Highway 44 (East 104th Avenue west of Highway 2). Access will be needed for the purpose of ground water monitoring activities. These will include the drilling of boreholes and the installation of monitoring wells as well as long-term ground water sampling of the wells on a quarterly basis. Access will be needed for six sites which are described by Section as follows.

Section 14 (T2S, R67W)

E-38 is a site for the installation of a cluster of three wells along the west side of Highway 2, approximately 1,200 feet (ft) northeast of the intersection of East 96th Avenue. The site is 900 ft east of the west section line and 900 ft north of the south section line lying in the southwest quarter, southwest quarter of Section 14.

E-50 is a site for the installation one or more wells along the west side of Highway 2. It is 3,100 ft east of the west line and 3,500 ft north of the south line of Section 14 and lies in the southwest quarter, northeast quarter of Section 14.

E-51 is at the site of an existing shallow well where an additional 1 or 2 wells will be installed. The site is approximately 3,800 ft east of the west line and 4,300 ft north of the south line of Section 14 in the northwest quarter, northeast quarter of Section 14.

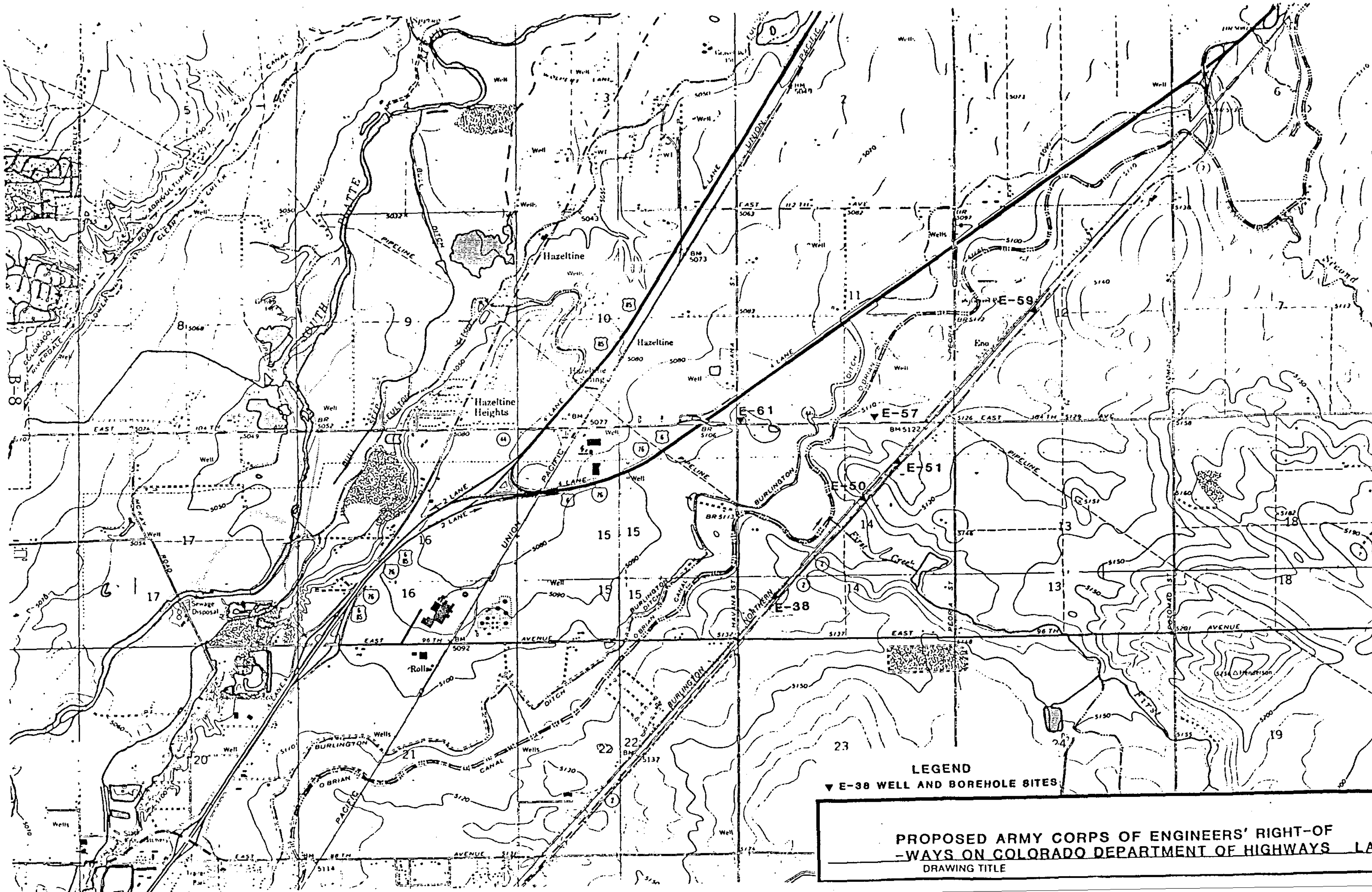
Section 11 (T2S, R67W)

Site E-57 is along the north side of Highway 44 (East 104th Avenue west of the junction with Highway 2) which runs along the south line of Section 11. The site is about 3,500 ft east of the west line and 30 ft north of the south line lying in the southwest quarter, southeast quarter of Section 11.

Site E-61 also is along the north side of Highway 44 approximately 100 ft east of the west line and 30 ft north of the south line in the southwest quarter, southwest quarter of Section 11.

Section 12 (T2S, R67W)

Site 59 lies along the northwest side of Highway 2, approximately 1,900 ft east of the west line and 2,800 ft north of the south line in the southeast quarter, northwest quarter of Section 12.



PROPOSED ARMY CORPS OF ENGINEERS' RIGHT-OF-WAYS ON COLORADO DEPARTMENT OF HIGHWAYS LAN

DRAWING TITLE

APPDENDIX C
FIELD DOCUMENTATION FORMS

ESE ENVIRONMENTAL SCIENCE AND ENGINEERING, INC.
7332 SOUTH ALTON WAY • SUITE H-I
ENGLEWOOD, COLORADO 80112 • 303/741-0639

PAGE________OF________

RECORD OF ACTIVITIES AT DRILL SITE

Boring Number:__________ Well Number__________ Date:__________

Location:__________ Project Number:__________

Drill Site Geologist:__________

Drill Site Geologist __________ Date __________

Figure C-1
RECORD OF ACTIVITIES AT DRILL SITE

SOURCE: ESE, 1987

Prepared for:
U.S. Army Program Manager's Office For Rocky Mountain Arsenal
Aberdeen Proving Ground, Maryland

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ENGLEWOOD, COLORADO 80112 • 303/741-0639

PAGE______ OF______

BOREHOLE SUMMARY LOG

Borehole __________ Well __________

Project Name and Location __________ Project Number __________

Drilling Company __________ Driller __________ Rig Number __________

Drilling Method(s) __________

____

Size(s) and type(s) of bit(s) __________

Borehole Diameter _____ in. _____ cm. _____ ft. _____ cm. to _____ ft. _____ cm.

_____ in. _____ cm. _____ ft. _____ cm. to _____ ft. _____ cm.

Sampling Methods __________

Total Number Soil Sampling Tubes __________

Total Number Core Boxes __________

Number of Gallons Lost Drilling Fluid __________

Date/Time Started Drilling __________

Date/Time Completed Drilling __________

Total Borehold Depth _____ ft. _____ cm.

Depth to Bedrock _____ ft. _____ cm.

Depth to Water _____ ft. _____ cm.

Water Level Determined By? __________

Borehole Completed as Monitoring Well? __________

Date/Time Grouting Completed __________

Depth of Tremmie Pipe __________

Gallons of Grout __________

Materials Used __________

Comments __________

____

____

Wellsite Geologist __________ Date __________

Checked for Grout Settlement on __________ by __________

Amount of Grout Added __________

All Measurements from Ground Level

Reviewed by __________ Date __________

Drill Site Geologist __________ Date __________

Figure C-2
BOREHOLE SUMMARY LOG

SOURCE: ESE, 1987

Prepared for:
U.S. Army Program Manager's Office
For Rocky Mountain Arsenal
Aberdeen Proving Ground, Maryland

ESE ENVIRONMENTAL SCIENCE AND ENGINEERING, INC.
7332 SOUTH ALTON WAY • SUITE H-I
ENGLEWOOD, COLORADO 80112 • 303/741-0639

WELL CONSTRUCTION SUMMARY

Borehole ______________ Well ______________

Project Name and Location ______________ Project Number ______________

Drilling Company ______________ Driller ______________ Rig Number ______________

Drilling Method(s) ______________

____

Borehole Diameter ____ in. ____ cm. ____ ft. ____ cm. to ____ ft. ____ cm.
____ in. ____ cm. ____ ft. ____ cm. to ____ ft. ____ cm.

Size(s) and types of Bit(s) ______________

____

Size and Type PVC ______________

Total Borehole Depth ____ ft. ____ cm.

Depth to Bedrock ____ ft. ____ cm.

Depth to Water ____ ft. ____ cm.

Water Level Determined By ______________

Length Plain PVC (total) ____ ft. ____ cm.

Length of Screen ____ ft. ____ cm.

Total Length of Well Casing ____ ft. ____ cm.

PVC Stick Up ____ ft. ____ cm.

Depth to Bottom of Screen ____ ft. ____ cm.

Depth to Top of Screen ____ ft. ____ cm.

Depth to Top of Sand ____ ft. ____ cm.

Depth to Top of Bentonite ____ ft. ____ cm.

Sampling Method(s) ______________

Date/Time Start Drilling ______________

Date/Time Finish Drilling ______________

Date/Time Start Completion ______________

Date/Time Cement Protective Casing ______________

Materials Used ______________

Plain PVC ______________

Slotted PVC ______________

Bentonite Pellets ______________

Bentonite Granular ______________

Cement ______________

Sand ______________

Water added during completion ______________

Water added during drilling ______________

Total Gallons of water added ______________

Drill Site Geologist ______________ Date ______________

Date/Time/Personnel Internal Mortar, Cement Pad, and Weep Hole Installed ______________

Date/Time/Personnel Casing Painted ______________

Date/Time/Personnel Numbers Painted ______________

Materials Used ______________

Top of Protective Casing to Top of PVC ____ ft. ____ cm.

Top of Protective Casing to Weep Hole ____ ft. ____ cm.

Top of Protective Casing to Internal Mortar ____ ft. ____ cm.

Top of Protective Casing to Top ofCement Pad ____ ft. ____ cm.

Top of Protective Casing to Ground Level ____ ft. ____ cm.

COMMENT/NOTES

____

____

____

____

Reviewed By ______________ Date ______________

Drill Site Geologist ______________ Date ______________

Figure C-3
WELL CONSTRUCTION SUMMARY
Page 1 of 2

SOURCE: ESE, 1987

Prepared for:
U.S. Army Program Manager's Office
For Rocky Mountain Arsenal
Aberdeen Proving Ground, Maryland

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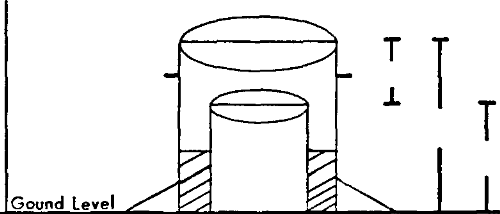
ENGLEWOOD, COLORADO 80112 • 303/741-0639

Borehole: ______________ Well: ______________

Depth-Feet	Soil/Rock Type	Well Completion	Description
			

Drill Site Geologist: ______________ Date: ______________
Reviewed By: ______________ Date: ______________

Figure C-3
WELL CONSTRUCTION SUMMARY
Page 2 of 2
SOURCE: ESE, 1987

Prepared for:
U.S. Army Program Manager's Office
For Rocky Mountain Arsenal
Aberdeen Proving Ground, Maryland

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ENGLEWOOD, COLORADO 80112 • 303/741-0639

SOIL/CORE SAMPLE SHEET

CHAIN OF CUSTODY

BORE: ____________

Core/Sample Interal (Ft.)	Recovery (Ft.)	Box/Sample Tube Number	Comments

Relinquished By:(Name/Company/Date/Time) Received By:(Name/Company/Date/Time)

1. ____________
2. ____________
3. ____________
4. ____________

Figure C-4
SOIL/CORE SAMPLE SHEET
CHAIN-OF-CUSTODY
SOURCE: ESE, 1987

Prepared for:
U.S. Army Program Manager's Office
For Rocky Mountain Arsenal
Aberdeen Proving Ground, Maryland

ESE ENVIRONMENTAL SCIENCE AND ENGINEERING, INC.
7332 SOUTH ALTON WAY • SUITE H-I
ENGLEWOOD, COLORADO 80112 • 303/741-0639

BOREHOLE ____________

SHEET ________ OF ________

BOREHOLE OR WELL ABANDONMENT REPORT

BORING NUMBER: ________ DATE ________

PROJECT NUMBER: ________ TASK NUMBER: ________

PROJECT DESCRIPTION: ________

BEGAN DRILLING: ________ ENDED DRILLING: ________

	DEPTHS	DATES MEASURED
Total Depth:		
Sampled to:		
To Water:		
To Mud:		
Caved Hole:	____ to ____	
	____ to ____	

ITEMS LEFT IN THE HOLE

Description: ________ Depth: ________

GROUT BACKFILL

Initial Quantity: ________ Date: ________

Quantity Added: ________ Date: ________

________ Date: ________

REASON FOR ABANDONMENT: ________

Figure C-5
BOREHOLE OR WELL ABANDONMENT REPORT
SOURCE: ESE, 1987

Prepared for:
U.S. Army Program Manager's Office For Rocky Mountain Arsenal
Aberdeen Proving Ground, Maryland

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DRILL SITE GEOLOGIST DAILY REPORT

Geologist: ______ Date: ______

Borehole/Well: ______ Task: ______

Drill Rig/Drill Crew: ______

Daily Crew Mobilization: ______ Move & Set Up: ______

Well Completion: ______ Decon: ______

Down Time: ______

Stand By: ______

	Feet Sampled	Feet Recovered	% Recovery
Continuous Soil Sampling:			
Continuous Rock Core:			

Auger Drilling: ______ Rotary Drilling: ______

Corehole Reaming: ______ Materials Supplied By Driller: ______

Total Hours Drill Site Geologist: ______

Comments: ______

Driller/Date: ______

Drill Site Geologist/Date: ______

Reviewed By/Date: ______

Figure C-6
DRILL SITE GEOLOGIST DAILY REPORT

SOURCE: ESE, 1987

Prepared for:
U.S. Army Program Manager's Office For Rocky Mountain Arsenal
Aberdeen Proving Ground, Maryland

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PAGE________OF________

DAILY ACTIVITY SUMMARY

Personnel____________________ Date____________________

Time Start__________ Time Stop__________ Total Hours__________

Borehole/Well	Task	Activity/Materials Used	Hours

Personnel	Date	Reviewed By	Date

Figure C-7
DAILY ACTIVITY SUMMARY

SOURCE: ESE, 1987

Prepared for:
U.S. Army Program Manager's Office For Rocky Mountain Arsenal
Aberdeen Proving Ground, Maryland

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SHEET______ OF______

Borehole:__________________ Well Number:__________________

Depth – Feet	Tube Number Tube Interval	Recovery	Sample Number	Sample Interval	Unified Soil Classification	SOILS LOG Description

Drill Site Geologist:__________________ Date:____________

Reviewed By:__________________ Date:____________

Figure C-8
SOILS LOG

SOURCE: ESE, 1987

Prepared for:
U.S. Army Program Manager's Office For Rocky Mountain Arsenal
Aberdeen Proving Ground, Maryland

ESE, Inc. CORE LOG By ________ Date ________ BORE________ Well(s) ________ Page ___of___

BOX no.	DEPTH	Rec. Int.	Weath.	Structure / Bedding		Hard-ness	Perm.		Mineralogy		Color	Texture / Grain Size	Lith. Char.	Lith. Class	Description / Comments
			U S	Angle	Desc.	S H	1° L H	2° L H	Min.	Habit	M G	cl st sd gr mm .01 1.0 100		Ft	CM (Scale 1"=________ft)

*Reviewed By*________ *Date*________

ESE, Inc. BORE________ WELL(S)

Figure C-9
CORE LOG

SOURCE: ESE, 1987

Prepared for:
U.S. Army Program Manager's Office
For Rocky Mountain Arsenal
Aberdeen Proving Ground, Maryland

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ENGLEWOOD, COLORADO 80112 • 303/741-0639

SHEET ______ OF ______

WELL DEVELOPMENT DATA

Bore ______________ Well ______________

Project ______________________ Project Number ______________________

Date(s) Developed ______________________ Date Installed ______________________

Personnel (Name/Company) ______________________ Well Diameter (I.D.) ______________ in.

______________________ Anulus Diameter ______ in. ______ ft. to ______ ft.

Rig Used ______________________ ______ in. ______ ft. to ______ ft.

Pump (Type/Capacity) ______________________ Screen Interval ______ ft. to ______ ft.

Bailer (Type/Capacity) ______________________ ______ ft. to ______ ft.

Water Source ______________________ Casing Height (Above G.L.) ______________ ft.

Measured Well Depth TOC (Initial) ______ ft. Bottom of Screen (Below G.L.) ______________ ft.

(Final) ______ ft.

Water Level TOC/Date/Time (Initial) ______________________________

(after 24 hrs.) ______________________________

Feet of Water in Well ______ ft. x ______ gallons/foot = ______ gallons casing/anulus volume

Drilling Fluid Lost ______________ gallons One Purge Volume ______________ gallons

Purge Water Lost ______________ gallons Minimum Purge Volume ______________ gallons

Added Water ______________ gallons Total Purge Volume ______________ gallons

Casing/Anulus Volume ______________ gallons Volume Measured By ______________

Surge Technique ______________

Calibration: pH Meter Used: ______________________________

pH 7.00 = ______ at ______ °C, pH 10.00 = ______ at ______ °C

Conductance Meter Used: ______________________________

Standard ______ umhos/cm at 25°, Reading ______ umhos/cm at ______ °C

Purge Volume	Time	Temp. °C	pH	Conductance at 25°C	Physical Characteristics (clarity, odor, sand content, color)
Initial					
Final					

Remarks: ______________________________

____

____

Collected by ______________________________
Signature Date

Checked by ______________________________
Signature Date

Figure C-10
WELL DEVELOPMENT DATA

SOURCE: ESE, 1987

Prepared for:
U.S. Army Program Manager's Office
For Rocky Mountain Arsenal
Aberdeen Proving Ground, Maryland

APPENDIX D

COMMENTS AND RESPONSES TO THE

TASK 39 DRAFT FINAL TECHNICAL PLAN

MAY 1987

The Task 39 Draft Final Technical Plan was distributed on May 19, 1987 to all Organization and State (OAS). Comments were received from the Colorado Department of Health on July 20, 1987; from Shell Oil Company on August 28, 1987; and from the U.S. Environmental Protection Agency (with Camp, Dresser & McKee, Inc.) in September 1987 (undated).

All specific written comments and response are contained in the following appendix.

RESPONSES TO THE
COLORADO DEPARTMENT OF HEALTH COMMENTS ON THE
TASK 39 DRAFT FINAL TECHNICAL PLAN
MAY 1987

Comment 1: Executive Summary, Page ix	The rationale for conducting a second and separate RI/FS effort for RMA offpost areas should be presented in the technical plan. The RMA RI/FS was initiated over two years ago to evaluate the nature and extent of all contamination caused by 45 years of handling and disposing hazardous substances, pollutants and contaminants at RMA. The ongoing RMA RI/FS is not constrained by the present property boundaries of the facility. In addition, much of the information needed to complete an "Offpost RI/FS", such as soil and water cleanup levels and identification of feasible remediation measures, will be generated in the overall RMA RI/FS. Therefore, it is not evident that it is possible or appropriate to conduct a complete and separate "Offpost RI/FS".
Response:	The justification for a separate offpost RI/FS and ROD centers around the goal of cleaning up the offpost area in an expedited manner. Currently, the schedule for the onpost ROD extends into 1993, and it is our opinion that the offpost RI/FS and ROD can be completed well in advance of this date. Because the potential exposure pathways for the offpost contamination are expected to be less complicated than those for the onpost, cleanup levels for all of the onpost media may not be necessary. If they are required, however, the schedule indicates that these action levels should be available in draft form in time to support the offpost program.

<u>Comment 2</u>: Executive Summary, Page ix

The offpost RI/FS must evaluate the <u>nature</u> of the hazardous substances, pollutants or contaminants present in the offpost study area. GC/MS screening is needed to determine which, if any, non-target organic contaminants are present in offpost soils, sediments, surface water and groundwater. The evaluation of the nature and extent of contamination should be conducted in all areas where RMA contaminants are known to exist or have the potential to migrate. The facility data evaluation should extend to the north and northwest of the facility and to the west of the facility where the U.S. EPA has identified RMA contamination which is contributing to the degradation of public and private drinking water supplies.

<u>Response</u>:

The primary avenue by which surface water, sediments, and soils may become contaminated offpost is from ground water infiltration. Therefore, nontarget organic contaminants are most effectively screened for in ground water. All of the samples collected under Task 44, the regional ground water monitoring program, have been screened by gas chromatography/mass spectrometry (GC/MS).

Another scenario by which nontarget analytes may migrate to offpost sediments and surface water is via onpost surface drainage into First Creek. GC/MS may be appropriate for First Creek sediments and surface water offpost to determine if nontarget contaminants are present that are not picked up in the Task 44 ground water screening. A program for additional offpost surface water and sediment monitoring is being considered presently by the Army. The details of this effort will be sent to the Organizations and the State (OAS) for review prior to the initiation of field work.

Soil contamination offpost will only be present where direct interaction with ground water takes place. Contaminated soil is only significant where it presents a pathway to the environment. Therefore, areas of concern are those where a shallow ground water table exists or irrigation with contaminated water takes place. Both of these scenarios can be adequately addressed in the EA by examining ground water quality and conservatively estimating partitioning between the water and the soil.

The area west of Rocky Mountain Arsenal (RMA) is under the jurisdiction of the U.S. Environmental Protection Agency (EPA). The RI/FS conducted by the EPA did not trace contamination found in their study area back to specific source areas on RMA. It is therefore not appropriate for the Army to assume responsibility for the screening of nontarget organic contaminants in this area.

Comment 3: Executive Summary, Page xi

In addition to the evaluation of surface and groundwater, the RMA RI/FS must also evaluate the nature and extent of soils contamination on and offpost. Data from the offpost CAR indicates that contaminated groundwater is discharging to the surface water flow of First Creek, indicating that there is a very shallow groundwater table in this area. Therefore, it is probable that the sediments and soils in this area are also contaminated. The need for Offpost remediation must be based on a complete assessment of the nature and extent of contamination in soils and sediments.

Response:

We are in agreement that the RI/FS must evaluate the extent of surface water and sediment contamination offpost. We also concur that the First Creek Drainage,

just north of RMA, is the area where surface water and sediments are most likely to be affected by contaminated ground water. Preliminary sediment sampling and analysis was performed under the offpost Contamination Assessment Report (CAR) (ESE, 1987). Offpost surface water monitoring has been continuing on a quarterly basis under Task 44. However, we are in the process of identifying additional surface water sampling locations for analyses in the offpost area. We are also outlining locations for additional sediment sampling and analyses. The details for sampling and analysis will be outlined in a letter which will be sent to the OAS prior to the initiation of field activities.

If soil contamination is present in the offpost area, it is due to interaction with contaminated ground water which has migrated from onpost areas. This interaction could be a result of direct contact with ground water or contact after pumping and irrigation. Both of these scenarios can be adequately assessed in the EA by examining ground water quality, assessing partitioning between the water and the soil, and addressing the specific pathways to the environment. This analysis will be conducted in a conservative manner in the EA to ensure that remediation will adequately protect the public health and environment.

Comment 4:
Page 1-2

Given the findings of the April 1987 Offpost CAR, it is inaccurate to describe the existence of offpost contamination as "potential". The last sentence of the second paragraph should state that substantial offpost contamination has been confirmed.

Response:

This comment has been noted and the text will be modified accordingly.

Comment 5: Page 1-3

As stated previously, the specific objectives of the RI/FS must be expanded to include an assessment of the nature and extent of contamination of the sediments, soils and surface water offpost of RMA in addition to the groundwater. Task 39 should identify, compile and implement an investigation to correct the data deficiencies discussed in past offpost contamination studies. At a minimum, past studies (and the State) have identified the following data needs:

- o Identification of target and non-target contaminants in groundwater, surface water, soils, and sediments.
- o Definition of the local geology of the Denver and Arapahoe formations within the study area.
- o Definition of the contaminant distributions, flow paths and flow rates in the Alluvial and bedrock formations.
- o Definition of the extent of contamination, and the mechanism(s) for transport of contaminants to and from surface water (i.e., First Creek, O'Brian Canal, Burlington Ditch, Barr Lake and the South Platte River).
- o Definition of the extent of contamination in soils and sediments.

Response:

We are in agreement that screening for nontarget analytes should be performed on ground water. For the reasons outlined in response to comment #2, we believe that limited nontarget analyte screening is appropriate for surface water and sediments. This screening of surface water and sediments will be outlined in a letter which will be sent to the OAS for review prior to the initiation of activities.

Definition of the local geology in the Denver Formation is being addressed by drilling deep borings

(approximately 120 feet (ft) deep) in areas downgradient of the RMA boundary. To date, 17 deep borings have been drilled offpost or right at the RMA boundary. These borings have been used to define the geology in the Denver Formation downgradient of the RMA boundary.

Based upon the regional hydrogeology, if bedrock contamination were to occur, the uppermost Denver units at the boundary and offpost are the most likely to be contaminated. Therefore, wells have been installed in the 1st and 2nd Denver sands. Water quality and hydrologic data from these wells will be used to assess the need for deeper wells and the corresponding geologic information. The need for localized geologic data in the Arapahoe Formation will be based upon monitoring in the overlying Denver Formation.

To date, the offpost well installation program has consisted of 15 alluvial wells and 14 Denver wells to supplement the existing network. The primary objective of the activities is to assess contaminant distributions, flow paths, and gradients in and between the alluvium and the Denver Formation. Onpost aquifer test results will be used in conjunction with offpost aquifer tests and soil characteristics to define aquifer properties (transmissivity, specific yield, storage coefficients, etc.). This data will be integrated to examine flow rates in the aquifers of concern.

Offpost surface water sampling is currently being conducted under Task 44. The mechanisms for transport of contaminants to and from surface water in the study area are also being evaluated in the RI.

Sediment sampling and analysis was performed in the offpost CAR (ESE, 1987). Additional sediment analysis is being considered for the offpost RI. We will be outlining the details for the sediment sampling and analysis in a letter. This letter will be sent to the OAS for review prior to the beginning of field activities.

Comment 6: Page 1-3

Task 39 as proposed must also be supported by and dependent upon Task 35, the RMA Endangerment Assessment. (See comments 10 and 29).

Response:

Task 39 will be supported by Task 35, the onpost EA. This task will be added to the list of applicable tasks on page 1-3.

Comment 7: Page 1-4

The list of RMA contaminants in the text is not inclusive. The discussion of RMA contaminants in this section should not be limited to those found only in groundwater.

Response:

The list of contaminants on p. 1-4 is only a summary of those identified by Spaine et al. (1984) and is not intended to be an all-inclusive listing of RMA contaminants. A more complete discussion is provided in the Contamination Assessment Report (ESE, 1987).

Comment 8: Page 1-6

The statement in the text that diisopropyl methyl phosphonate (DIMP) "may not be a hazardous substance, pollutant or contaminant" is inaccurate. The terms "pollutant or contaminant" are defined in CERCLA to include, "but not be limited to, any element, substance, compound or mixture, including disease causing agents, which after release into the environment and upon exposure, ingestion, inhalation or assimilation into any

organism either directly from the environment or indirectly by ingestion through food chains, will or may reasonably be anticipated to cause death, behavioral abnormalties, cancer, genetic mutation, physiological malfunctions or physical deformations...." CERCLA, Section 101(33).

DIMP is a by-product and waste product from the manufacture and demilitarization of the Army chemical warfare nerve agent, GB. Nerve agents were manufactured to kill humans in minute doses. Although there is no human toxicity data on DIMP, toxicological studies on laboratory animals (rats, mice, rabbits, etc.) conducted by the Army prove that DIMP is a moderately toxic organophosphate-like poison. In at lease one study, DIMP was fatal to rabbits through the skin absorption route of exposure. The existing toxicological data is limited to a few subchronic animal studies. However, it is ludicrous to suggest that the most widespread organic contaminant at RMA is merely an indicator compound which will continue to be monitored only "as a delineation of migration pathways." These statements must be deleted from the text.

Response: Available data presently indicates that DIMP comes within the definition of "pollutant or contaminant" in CERCLA Section 101(33), 42 U.S.C. Section 9601(33), although not within the meaning of "hazardous substance" as defined in that section. The text will be revised accordingly to reflect that DIMP is a CERCLA "pollutant or contaminant."

Comment 9:
Page 1-6

The April 1987 Offpost CAR shows elevated concentrations of DBCP, organosulfurs and volatile solvents in areas 1-1/4 to 1-1/2 miles downgradient from the north

boundary of RMA. These are not "areas immediately north" of the RMA boundary. The text should be modified accordingly.

Response: The statement in the first paragraph of page 1-6 is clearly directed at delineating how these contaminant distributions vary relative to the most widespread organic contaminant, DIMP. The locations for detections of these groups of contaminants are shown in Appendix A. We believe that this introductory paragraph is correct in describing organochlorine pesticides, organosulfur compounds, volatile organic compounds, dibromochloropropane (DBCP) and dicyclopentadiene (DCPD) distributions relative to DIMP.

Comment 10:
Page 1-6

The discussion and use of "water quality guidance levels" in Task 39 is inconsistent with Section 121(d) of CERCLA, which specifies the degree of cleanup required for hazardous substances, pollutants and contaminants released into the environment. The guidance levels unilaterally set by the Army have not been determined to be the action levels for remediation of contaminated water nor have they been shown to be levels that define "risk" to individuals. Section 121(d) states, in pertinent part, that "such remedial action(s) shall require a level or standard of control which at least attains maximum contaminant level goals (MCLGs) established under the Safe Drinking Water Act and water quality criteria established under Section 304 or 302 of the Clean Water Act, where such goals or criteria are relevant and appropriate under the circumstances of the release or threatened release". (emphasis added).

The Army water quality guidance levels do not meet these criteria. MCLGs are the relevant and appropriate standards where, as here, the designated and potential use of the Alluvial aquifer is the primary drinking water supply for the current and future residents of South Adams County.

For many RMA pollutants where no promulgated criteria exist, such as DIMP, Section 121 states that the degree of cleanup must be "at minimum (that) which assures protection of human health and the environment." For DIMP, and similar RMA contaminants, which do not have any human toxicity data that defines a level to assure protection of human health and the environment, the degree of cleanup must be that which is technically feasible using available control technologies, (i.e., granular activated carbon treatment for contaminated water.) It is not appropriate to generate human toxicity data by potentially exposing Adams County residents to DIMP and other RMA compounds through the public and private drinking water supplies. Therefore, for RMA contaminants with little or no human toxicity data, the analytical detection limit must be used as the ARAR unless it is technically impractical.

The ARARs for the RMA RI/FS must be determined using the criteria and analysis required by Section 121 of CERCLA. That analysis should be conducted in the Task 35 Endangerment Assessment in coordination with the RMA "How Clean is Clean" subcommittee. Therefore, all references in the text and figures using these improperly derived "water quality guidance levels" must be deleted from the text.

Response: Language on page 1-6 of the referenced plan was incorrect in stating that these levels have preliminarily been determined to be "safe" levels in drinking water. This language has been revised to reflect their actual purpose and interpretation in the context of this study.

The State of Colorado interpretation of SARA Section 121 is noted. It is also noted that there are many contaminants, in addition to DIMP, for which direct human toxicity data is sparse, inadequate, or nonexistent. Included among such contaminants are many for which regulatory standards and criteria have been promulgated based upon risk assessment methods designed to protect human health, using non-human data and appropriate interspecies safety factors. Similar procedures will be used to evaluate appropriate water quality objectives for DIMP. Applicable or relevant and appropriate requirements (ARARs) for the RI/FS will be determined using the criteria and analysis required by Section 121 of CERCLA. The water quality guidance levels are not intended as a substitute for that analysis. It will be conducted in coordination with RMA "How Clean is Clean" Committee using procedures recommended by that committee.

In the near future, the Army will identify potential ARARs for the hazardous substances, pollutants or contaminants found in the Offpost Operable Unit. These potential ARARs will be forwarded to the OAS for review and comment, and thereafter will be applied in accordance with the provisions of the RI/FS Process Document.

Comment 11: Page 1-7, Section 1.3	To accurately reflect the conditions of the north and northwest boundaries of RMA, the text should state that previous investigations, including the 1987 Offpost CAR, have determined that contaminants have migrated and are continuing to migrate offpost, and appears to be circumventing the North and Northwest Boundary Containment Systems.
Response:	The referenced report clearly states that previous investigations at RMA, including the offpost CAR, have determined that contaminants have migrated offpost. Since these investigations are complete, they can not address present conditions. The extent to which contaminants may be presently migrating offpost is being evaluated under the current Tasks 25 and 36.
Comment 12: Page 1-7	The offpost "study area" is not conservative and fails to include an area known to be impacted by contamination migrating off the Arsenal. The report should state that groundwater and surface water movement also occurs off the RMA west boundary. Limiting Task 39 to the area north of 80th Avenue ignores the identified groundwater contaminant flowpaths from RMA affecting the water quality of the private and public drinking water supply in the area off the RMA west boundary. In addition, the lateral extent of DIMP, chloroform, chloride and fluoride in the alluvium were not defined in the Offpost CAR. The groundwater flowpaths along the South Platte are to the northeast and may extend or "come to rest" beyond the limits of the study area. The statements in the text are inaccurate and should be modified accordingly.
Response:	The area west of RMA is under the EPA's jurisdiction. The EPA has identified potential sources of

contamination for this area other than RMA. Therefore, it is not appropriate for the Army to assume responsibility for this area.

We believe that the study area does define a conservative zone for study. This statement is not only based on water quality data at known points, but it is also based upon assessments of the regional hydrogeology and known areas of contamination near the RMA boundary. Based upon these evaluations, we believe this study area includes the zones which would be adversely impacted by contamination from RMA.

Based on data obtained since December 1985, RMA target organic analytes have not been detected at station 12AAB which is located on the South Platte River downgradient of the study area. Monitoring at this station will continue to substantiate whether RMA contaminants may be migrating beyond the boundaries of the present study area via the South Platte River.

Comment 13:
Page 1-17

Although the report identifies the Arapahoe formation, Denver formation and unconsolidated alluvial and eolian surficial deposits as the "strata of primary concern" in the study area, there are no regular monitoring wells existing or proposed for monitoring the Arapahoe aquifer either on or offpost, and only one existing monitoring well in an uppermost sandstone lens of the Denver formation. These deficiencies must be corrected.

Response:

The present remedial investigation has installed Denver wells in 1st and 2nd sand units downgradient and to the west of the North Boundary Containment System (NBCS). Based upon the hydrogeology at RMA and evaluation of travel times, the uppermost Denver units at the

boundaries and offpost would be the most likely bedrock units to show contamination, if contamination is present. We believe that defining the vertical extent of contamination is most efficiently accomplished by working down to horizons which show no contamination. We do not believe that arbitrarily installing wells at depths corresponding to the Arapahoe will be an effective approach to defining the vertical extent of contamination.

Comment 14: Page 1-7

The text and Figure 1.3-7 should indicate that elevations of bedrock surface are "preliminary" drawings or estimates of the orientation of paleochannel depressions because they are based on a limited amount of data.

Response:

Bedrock surface contour maps are always based on a "limited amount of data" in the sense that contours must be interpolated between known data points. We agree that the map is "preliminary" because it will be updated to reflect new data that is gathered during current programs.

Comment 15: Page 1-17

The discussion of the hydrologic and geologic characteristics of the Denver Formation should be referenced. The discussion of groundwater flow in the text is regional in scope and appears to be based on studies conducted by the Colorado State Engineer's (CSE) Office. These studies are predominantly performed to determine whether the groundwater flow in an aquifer is sufficient to supply a source of drinking water. Using regional data and conclusions from the CSE studies to evaluate the potential for localized contaminant flow through the Denver Formation may therefore be inappropriate.

Response: Since the discussion of the Denver Formation was intended to provide an introductory description of the geohydrology in the study area, a regional interpretation is appropriate. However, recognizing the importance of localized flow within the Denver Formation, the RI will include a discussion of local flow patterns.

Comment 16:
Page 1-17

The Denver Formation in the offpost study area is less than the 230 feet minimum thickness described. The text should be modified to correct this error. The descriptions of these bedrock formation should be referenced. It should be noted that these are regional estimates unconfirmed by investigations of the local study area.

Response: We agree that the stated ranges of thicknesses for the Denver Formation are not appropriate for the offpost study area. This range applies more to the onpost area. A more realistic estimate will be included in the text for the offpost study area.

Comment 17:
Page 1-20

The section in the report on land use and biota should describe the potential for growth if a new international airport and Highway E-470 are constructed within the immediate vicinity of RMA. It should also be noted that the primary public and private drinking water supply for the area is the unconsolidated quaternary Alluvial aquifer that has been contaminated by RMA disposal practices.

Response: The section on land use and biota is an introductory paragraph intended to provide general comments about the present land use in the study area. Section 9.2 outlines plans under the EA to evaluate future land use

and future populations at risk. This analysis will address potential transportation infrastructure development.

Comprehensive studies on consumptive use were performed in the study area under the Consumptive Use Programs I and II. These studies indicate that although the alluvial aquifer is used for drinking water, it is generally not the main source of water near offpost areas contaminated by RMA. The Arapahoe Formation is the principal aquifer used for drinking water near RMA.

Comment 18:
Page 1-20

Contrary to the statement in the text, the offpost CAR and the consumptive use studies have not provided a comprehensive assessment of contamination in the offpost study area. If this were true, there would not be a need to conduct Task 39. The deficiencies of previous efforts are described in the State's comments on the Offpost CAR. The text should be modified to state that previous studies provide a basis for a comprehensive assessment of contamination in the offpost study area, which will be conducted in Task 39.

Response:

The statement in the text that the offpost CAR (ESE, 1987) is a "comprehensive assessment" of offpost contamination is not intended to imply that the CAR is sufficient to supply the data needed for the EA/FS, and additional data are currently being gathered in the remedial investigation. We agree that the offpost CAR and other previous studies provide the basis for the more detailed study being performed under Task 39.

Comment 19:
Page 1-20

DIMP, chloride, fluoride and chloroform are the most widespread RMA contaminants detected offpost in the studies conducted to data.

Response: We would agree that detections of fluoride have been widespread in the study area. However, since fluoride is a naturally occurring ion in ground water, it is difficult to determine the extent to which it is attributable to RMA. Chloroform has also been detected frequently and at many locations in the study area. However, based on available data, chloroform does not appear to be nearly as widespread as DIMP. It is also unclear whether several offpost detections of chloroform are attributable to RMA.

Comment 20: Page 1-20, Table 1.4-1

This table and all references to "water quality guidance levels" should be deleted from the text.

Response: Table 1.4-1 has been deleted, as has use of the term "water quality guidance levels".

Comment 21: Page 1-29

The text should replace the phrase "areas immediately north", with the phrase "areas as much as one and one half miles beyond" the north boundary.

Response: The most significant contamination offpost of RMA has been found within one-half mile of the RMA north boundary. Other significant contamination has been detected right at the RMA northwest boundary. Detections of organic solvents, chlorinated pesticides, organosulfur compounds, and DBCP have occurred "as much as 1 1/2 miles beyond" the RMA north boundary. However, it is not clear if all detections of organic solvents and chlorinated pesticides are attributable to RMA. The text will be modified to reflect these facts.

Comment 22: Page 1-29

Please define the "non-RMA specific contaminants" in the report and give the basis for the characterization. The

interpretation of RMA specific contaminants or contaminants "solely from RMA" should not be limited to the listing of chemical species. The identification of RMA contaminants must also be based on source area information, chemical concentrations, and the defined groundwater, surface water, air and other flowpaths.

Response: Non-RMA specific contaminants in the offpost study area are defined as commonly used industrial solvents, petroleum hydrocarbons, heavy metals, and pesticides that could be attributable to sources other than RMA based upon industrial and agricultural activities in the study area. We are in complete agreement that a determination of whether these contaminants are from RMA must be based upon source area information, chemical concentrations, and an examination of potential flowpaths. Assessments of whether non-RMA specific contaminants are attributable to RMA will be based upon evaluation of this data.

Comment 23: Page 1-29, Paragraph 2, Sentence 2

The sentence should be corrected to state that, "Monitoring of the above-mentioned contaminants downgradient of the NWBS has general been restricted to areas immediately downgradient of the containment system".

Response: We are in agreement that several of the monitoring wells downgradient of the Northwest Boundary System (NWBS) are located right at the RMA boundary. However, Monitoring Wells 37334, 37335, 37336, 37360, and 37361 are located more than 1/4 mile downgradient of the NWBS. These wells have consistently shown significantly lower levels of contamination and fewer contaminants than wells located along the RMA boundary.

Comment 24: Page 1-29, Paragraph 3	The report should define the specific "additional groundwater data" that will be collected in this area to better define onpost and offpost sources and contaminant plumes.
Response:	The Consumptive Use Phase II Program involved considerable monitoring in the Irondale Area. The contaminants detected sporadically in this program could not be traced to a specific source, including RMA. The EPA and the Army have agreed that investigation of contaminants migrating to this area from the EPA study area would be under the jurisdiction of the EPA.
Comment 25: Page 1-30, Paragraph 1	Contamination of the Arapahoe aquifer by RMA contaminants is significant whether or not the contamination traveled down an improperly constructed well. The extent and transport mechanism of this contamination should be determined in the Offpost RI.
Response:	The water quality data available on the two Arapahoe wells mentioned on Page 1-30 are from a one-time sampling of each well. In both cases, DIMP was detected at levels near the Certified Reporting Limits. No other organic contaminants were detected. These levels of DIMP are orders of magnitude below the concentrations thought to be safe for drinking based upon the most recent toxicological studies. Since an examination of specific conductance, chloride, and pH values substantiate a mixing of alluvial and Arapahoe water, poor well construction is the most likely cause of contamination.
Comment 26: Page 1-30	An evaluation of the nature and extent of contamination in the Denver and Arapahoe formation is not possible due to the lack of monitoring data on the bedrock formations

in the offpost areas. The report should state the number of "high priority" Denver and Arapahoe formation wells which will be constructed in the Task 39 to correct this deficiency.

Response: The following is a listing of sites where wells have been installed and/or deep borings have been drilled downgradient of the NBCS under Tasks 25, 36, 39, and 44:

Site	Activity	Task
E-32	Deep Boring 1st Denver Sand 2nd Denver Sand	36
E-33	Deep Boring 1st Denver Sand	36
E-34	Deep Boring 1st Denver Sand	36
E-38	Alluvial Deep Boring 1st Denver Sand 2nd Denver Sand	39
E-39	Alluvial Deep Boring 1st Denver Sand 2nd Denver Sand	36
E-40	Alluvial Deep Boring 1st Denver Sand 2nd Denver Sand	36
E-42	Alluvial	36
E-46	Alluvial Deep Boring	39
E-47	Alluvial Deep Boring	39
E-55	Alluvial	25
E-63	Alluvial Deep Boring 1st Denver Sand	36

E-64	Alluvial (dry)	39
E-65	Alluvial	39
E-67	Alluvial	25
E-69	Deep Boring	36
E-73	Alluvial Deep Boring	39
E-74	Alluvial Deep Boring	39
E-75	Alluvial (dry)	39
EP-19	Deep Boring	36
EP-20	Deep Boring 1st Denver Sand	36
EP-21	Deep Boring	36
EP-28	Deep Boring	36
EP-72	Alluvial Deep Boring 1st Denver Sand 2nd Denver Sand	44

The location of these sites are shown in the Composite Well Drilling Program.

Comment 27:
Page 1-30

We concur with the conclusion that the limited number of surface water sampling locations and the collection of water quality samples only during low or no flow time periods, do not allow for a complete evaluation of the nature and extent of contamination of surface water. Given the conclusion in the Offpost CAR that groundwater discharge to surface water bodies is probably a major contaminant migration pathway in the area, a substantially greater surface water monitoring effort is warranted.

Response: Due to the likelihood of contaminated ground water recharging First Creek north of RMA, we are in agreement that additional surface water monitoring and investigation are needed to evaluate this pathway. Monitoring is currently being conducted under Tasks 39 and 44.

Comment 28:
Page 1-30

Two of the three up-stream surface water sampling sites are testing surface water quality over two miles upstream of the RMA offpost study area. The statements in the text that these sites evaluate surface water quality "as it enters" the study area, and that they are "on the southern and southeastern boundaries" of the study area are inaccurate. The text should be modified and an explanation should be given for the sampling locations used to evaluate upstream water quality in the offpost study area.

Response: It is agreed that two of the three upstream surface water sampling sites are evaluating surface water quality approximately 2 miles upstream of the RMA offpost study area. It is also agreed that these two sites do not necessarily evaluate surface water quality "as it enters" the study area. In particular, it is possible that contamination could be introduced to Burlington Ditch before the southern boundary of the study area is reached. However, there are no pathways from ground water to the canals because the bottoms of the canals are above the water table. Thus, surface runoff to the canal is the only plausible mechanism for contamination of the canal south of the study area. Since surface runoff would only be significant during storm events, it is believed that samples from this station would be representative of surface water quality as it enters the study area.

Comment 29:
Page 1-34

To meet the Task 39 objective of defining whether "there is a population exposed to contaminants and, if so, at what concentrations," a substantially greater sampling and analytical program must be established for every water well within the study area. Such a program should also identify and monitor: 1) users of contaminated water for irrigation and other purposes; 2) persons exposed to sediments, soils, and biota contaminated by the offpost migration of RMA chemicals, and 3) persons exposed to airborne contaminants.

The evaluation of persons potentially exposed to RMA contamination must extend at least three miles from the RMA boundaries and must extend further in areas where RMA contaminants have been found beyond three miles from RMA. This evaluation must be conducted considering source area contaminant "strengths", and current and projected release rates for contaminants before, during, and after remediation is implemented. These evaluations must be conducted consistent with the specific requirements of the Superfund Public Health Evaluation Manual (SPHEM).

An identical, but more detailed analysis, considering mechanisms and pathways of exposure is proposed as part of Task 35. It appears that the effort proposed in Task 39 is duplicative and less comprehensive than the Task 35 evaluation. For these reasons, conducting a separate risk assessment in Task 39 may prove to be of limited value. We recommend that the risk assessment proposed for Task 39 be deleted from the technical plan and incorporated into Task 35.

Response:

Consistent with the National Contingency Plan (NCP), the Army will regularly monitor a representative sampling of

ground water wells in the Offpost Operable Unit. The NCP does not require monitoring of all wells in an operable unit to ensure protection of the public health and environment. CDH cites no evidence to justify such a universal monitoring program in this instance, and the Army is not aware of any evidence that such an extraordinary monitoring effort is warranted here. The Army believes that given the nature and magnitude of the contaminants identified to date in the Offpost Operable Unit, a program of represetnative sampling remains the most responsible and protective means of investigating contamination in the Task 39 area.

Activities planned under Task 39 are neither duplicative of, nor less comprehensive than, activities planned under Task 35, and this has been addressed and specifically stated in Section 9 of the Technical Plan. The recommendation to incorporate the risk assessment activities of Task 39 into Task 35 is not well founded. Task 39 has been accelerated relative to the onpost assessment in Task 35 because of the more imminent hazard associated with contaminated offpost ground and surface water. Adoption of the State of Colorado's recommendation would result in a delay in identifying and implementing remedial actions that would reduce the risk to offpost populations.

Comment 30:
Page 1-35

The technical plan states that : "A major portion of Task 39 will be the performance of a feasibility study (FS). This study will evaluate long term remedial actions that could eliminate any unacceptable risk to the public or environment identified in the endangerment assessment (EA)". A feasibility study of remedial alternatives must not be limited to an evaluation of only long term remedial actions. All potential

alternatives, including short or long term actions must be evaluated.

A complete RMA feasibility study is proposed to be conducted in Task 28 which is not limited in scope by the current physical boundaries of RMA. The proposal to conduct a second feasibility study in Task 39 stet result in a duplicative and less comprehensive analysis for remediation of offpost areas. This assessment can only be projected by the State at this time because we have not received a copy of the Task 28 Technical Plan.

The evaluation of the type and extent of remediation of offpost areas is, by nature, substantially dependent upon the type and extent of remediation of the onpost areas. Onpost and offpost alternative evaluations and remediation cannot be conducted in isolation of each other. Contaminated soil/sediment cleanup volumes and the means to treat and /or dispose of these waste materials will be determined in Task 28. The potential offpost groundwater, surface water, and sediment/soil remedial actions are inextricably dependent upon the onpost remedies for source areas, plumes, and contaminated water capture and treatment systems. Only one feasibility study (Task 28) should be conducted to evaluate the alternatives for treatment and final remedial action for all contaminated media both on and offpost at RMA. Therefore, the proposed Task 39 FS should be incorporated into Task 28.

<u>Response</u>: The RI/FS program conducted under Task 39 for the offpost area includes an evaluation of the need for both short and long-term remedial actions. The short-term actions are addressed in the Interim Response Action (IRA) assessment and the long-term actions are addressed

in the formal FS for the offpost area. The FS will consider short-term IRAs that are planned or implemented prior to evaluation and selection of the long-term actions.

Separate FSs are being conducted for the onpost and offpost areas because they support two separate Records of Decision (RODs). As described in the Technical Program Plan (TPP), two RODs are being prepared in order to allow for development and implementation of remedial actions in the Offpost Operable Unit in an accelerated manner. Because of the complexity of the onpost situation, the ROD for this operable unit may require more time to develop than the Offpost ROD. The Army does not desire to prepare a single ROD and possibly delay the remedial actions in the offpost area.

In preparation of offpost remedial actions, the nature and extent of onpost contamination and the remedial actions being planned and implemented onpost will be considered. Although two FSs are being prepared at RMA, the intent is to fully integrate the remedial actions onpost and offpost so that the most effective means of addressing the situation at RMA is assured.

Comment 31:
Page 2-1

The objectives of the geotechnical program should also include:

- Definition of Denver and Arapahoe formation local geology in the offpost area.
- Characterization of Denver formation groundwater quality, flow rate and flow direction.
- Characterization of the Arapahoe formation groundwater quality, flow rate and flow direction.
- Characterization of the flow between the Alluvial aquifer and the Denver formation, and between the

Denver and Arapahoe formations in the offpost areas.

- o Delineation of the nature and extent of sediment/soil contamination of offpost areas.
- o Characterization of the nature and extent of sediment/soil contamination of offpost areas.

Response: The additional objectives for the geotechnical program mentioned in this comment are essentially "data needs" that were addressed in response to comment #5. The one comment that was not addressed pertains to characterizing flow between the alluvium and the Denver Formation and between the Denver and Arapahoe Formations. The potential for downward flow between the alluvium and Denver Formation is being assessed by installing cluster sites at four offpost locations and monitoring head differences between the two formations. Water levels in other alluvial and Denver wells are being monitored close to the RMA boundary for the same purpose. Emphasis has been placed on installing these wells in areas where alluvial ground water is contaminated.

The geology of the alluvium and Denver Formation is being evaluated at each cluster site by logging deep borings that extend typically over 100 ft into the Denver Formation. This data is evaluated in conjunction with hydrologic data to evaluate the relative importance of flow between the aquifers.

An assessment of flow between the Denver and Arapahoe Formations will be undertaken if contamination is found to be present in the lower Denver Formation. An evaluation prior to substantiation of the lower Denver Formation contamination would create unnecessary cross-

contamination risks without sufficient technical justification.

Comment 32: Page 2-1

Weathered or fractured shale units have been documented near the contact of the Denver and alluvial formations in the vicinity of the north boundary. These fractured shale units may exhibit hydraulic conductivities similar to or higher than adjacent sandstone units. The Denver aquifer well installation program must review the borehole material to detect the presence of fractured shale. If fractured shale is detected, monitoring wells screened across these units must be constructed.

Response:

It is agreed that fractured shale within the Denver Formation may exhibit hydraulic conductivities similar to that of adjacent sandstone units. However, due to the localized and discontinuous nature of these fractured materials, they are not considered as regionally transmissive zones and are not considered major units responsible for significant lateral flow in the Denver Formation. Therefore, wells completed within sandstone units are considered higher priority because they transmit the majority of water within the Denver Formation on a regional basis.

Even with proper well installation techniques, the placement of wells in areas where a shale layer is relatively thin may lead to a greater probability of cross-contamination between the alluvium and underlying Denver aquifers. The relevance of data obtained from wells completed in fractured shales to overall remediation must be evaluated on a case by case basis. We do not agree that wells should be installed at every location where fractured shale is encountered unless the well is fundamental to remediation and construction

would not add significantly to the risk of cross-contamination.

Comment 33:
Page 2-3

There appears to be a pathway for the migration of RMA contamination in the alluvial aquifer across the northwest boundary. The Offpost CAR and Task 39 indicate that a bedrock paleochannel in this region may act as a preferred pathway for contaminants. In addition, the potential for localized dilution of this plume from recharge from the Burlington Ditch and O'Brian Canal exists, and merits investigation. Therefore, a denser ground water monitoring well network in this area is needed. Series 37 wells 332, 333, 335 and 345 should continue to be monitored to delineate the northwest plume. Proposed well E055, a "low priority" monitoring well, should be constructed as soon as possible. Additional monitoring is needed in this region to provide the needed geologic and water quality information.

Response:

We are in agreement that additional monitoring was needed downgradient of the northwest boundary in the alluvial aquifer. To fill this need, an alluvial monitoring well has been installed at Site E-55 which is located approximately 2600 ft from the south line and 1600 ft from the west line of Section 22. This well is approximately 1800 ft downgradient of the NWBCS. An additional alluvial monitoring well has been installed at Site E-67 which is located approximately 2400 ft from the south line and 20 ft from the east line of Section 21. This is approximately 2900 ft downgradient of the NWBCS. Both of these wells were installed under Task 25 and data will be integrated into the offpost RI/FS. These wells are both shown in the composite well program report. Data from these wells will be evaluated and we

will assess the need for additional monitoring in this area.

Comment 34:
Page 2-4

The use of high, moderate and low priority designations for construction of new wells is confusing and often misleading the army has indicated that there is only sufficient time and funding to construct the "high" priority sites and very few "moderate" priority sites prior to completion of the RI/FS studies. Only those wells and boreholes planned for construction in this task should be presented in the technical plan.

For example, Section 2.1 states that twenty-three well and borehole sites are proposed in Task 39. However, table 2-5 shows that only five sites have been designated high priority, with four of the five sites shown as cluster wells. The cluster well sites are described as sites where the PMO will construct an Alluvial well paired with one or two new Denver wells. A close review of Section 2.1.2 reveals that one of the five sites designated "high" priority in table 2-5 is actually considered a "low to moderate" priority site (E-50). More importantly, the text indicates that in every case, only the Alluvial well at these sites is considered: high priority". All Denver formation wells are considered low priority, and therefore will likely not be constructed in Task 39.

The Task 39 high priority well construction program proposes to drill only four alluvial monitoring wells. At this time, the proposed Task 39 well construction program will only focus on the alluvial contamination downgradient of the north boundary. The program will not evaluate the two bedrock formations of "primary concern" and does not propose to evaluate the nature and

extent of contaminating off the northwest boundary. The program described in Task 39 will not collect the information necessary to achieve the objectives of Task 39 or to satisfy the statutory and regulatory requirements.

Response: It is agreed that the high, moderate, and low priority designations used for well sites has been confusing. However, there is a specific reason for these designations. Due to the long lead time required in the permitting process, it was necessary to request permits for all possible sites early in the program. Based upon the data available at the beginning of the program, many of these sites did not seem essential to the RI. These sites were identified as "low priority" but were permitted in the event that data collected from other sites indicated a need for installation. "Moderate Priority" wells were considered more likely to be required than "low priority" wells, but were not deemed essential at the beginning of the program. "High priority" wells were deemed essential to achieve the goals of the program based upon data available at the beginning of RI activities.

Although this system of designation may have caused confusion, the alternative approach would have been to permit sites later in the program and this could have created unnecessary delays in field activities.

Wells that have been installed in the study area are listed under Response #26. This list includes 15 alluvial wells, 17 deep borings, and 14 Denver wells. Many of these wells were listed as "moderate priority" in the Draft Final Technical Plan or were added to the program, and the OAS parties were notified in a Letter

Technical Plan. As mentioned in Response #26, many of these sites were developed under Tasks 36 and 25.

Comment 35:
Page 2-16

The description of the well construction procedures for Alluvial wells (screened from bedrock contact to 5 ft. above water table surface) may result in wells with excessively large screened intervals. A maximum screen length (i.e., 10 ft.) should be one criteria for well construction. Additionally, clustered Alluvial wells should be constructed in areas with thick Alluvial saturated zones.

Response:

This comment is not consistent with comment #9 made on Task 36. The Task 36 comment stated that alluvial areas with saturated thicknesses in excess of 20 ft should be monitored with alluvial well clusters. The Task 39 comment seems to suggest a maximum of 10 ft for a screened interval. Based upon the remoteness with respect to the source areas on RMA, we believe that substantial mixing would occur by the time contamination migrates to the offpost area. Therefore, stratification of the primary contaminants in the offpost study area is not expected to be significant enough to justify a maximum 10-ft screened interval. In addition, in areas where data is sparse or nonexistent, it is more appropriate to install one well to obtain preliminary water chemistry data before attempting to define any contaminant stratification.

Comment 36:
Page 2-18

The source of the "PMO-RMA approved water" used in the well construction program should be identified in the text. The approved water should be tested for target and non-target analytes and the results reported in Task 39.

Response: The "RMA approved water sources" have been either Deep Rock water or the RMA water supply from the Denver Water Board. All water from the RMA water supply is treated by carbon adsorption prior to use. Water sources are being analyzed routinely for RMA target analytes and randomly screened for nontarget analytes.

Comment 37: Page 4-1 The Task 39 chemical analysis program should be modified to include GC/MS screening for non-target analytes.

Response: GC/MS screening is being conducted under Task 44 on approximately 10 percent of the wells sampled. This screening will include offpost wells being monitored under Task 44. Findings from this screening will be incorporated into the Task 39 chemical analysis program.

Comment 38: Page 4-3 Please explain why the analytic method for DIMP is the only contaminant with a qualitative level of certification. Approximate detection limits should be included in this table.

Response: EPA Method 611 is a quantitative method for phosphorous-containing compounds in water. This correction has been made to the Technical Plan.

Comment 39: Page 6-3 The statement that Task 39 well installation will occur in areas where the soils are largely uncontaminated" is not based on actual data. This assumption is likely to be incorrect in surface water drainage downgradient from RMA and in areas with very shallow water tables. Proper worker safety and waste handling precautions for soils should be taken in areas such as the First Creek drainage, until actual sampling and analysis of soils and sediments defines the nature and extent of contamination.

Response: We are in agreement that sediments and soils may be contaminated in the First Creek surface water drainage and in areas with very shallow water tables. The safety procedures outlined in the Technical Plan have taken into account this possibility.

Comment 40:
Page 8-1

The report states that piezometric data will be collected from the bedrock well(s) to provide an indication of the magnitude of vertical gradients between aquifers. Given that all new Task 39 Denver formation wells have been designated "low priority" and that there is only one existing Denver well in the Offpost Revision III-360° monitoring program, the report should identify how this objective will be achieved.

Response: Several Denver wells have been installed under Tasks 36 and 39 in the offpost study area to help assess the vertical potential for ground water flow. These wells are identified in our response to comment #26.

Comment 41:
Page 8-1

The proposal to assess the propriety of potential offpost remedial actions on the basis of a ground water flow model, rather than a flow and transport model, should be reevaluated. A ground water flow model will not define the natural attenuation rates, effects of remedial actions, or residual contaminant concentrations that could remain after remediation.

Response; We are in agreement that a ground water flow and transport model would be beneficial in evaluating remedial actions and determining time required for cleanup. Solute transport will be analyzed in conjunction with evaluation of remedial actions. The most appropriate model or models to evaluate remedial

actions and time for cleanup are presently being evaluated under Task 39.

Comment 42: Page 9-1

The identification of the "primary pathway for contaminant releases from RMA" based on Offpost CAR data is premature. The Offpost CAR investigations merely confirms that shallow Alluvial ground water contamination exists. The RMA RI/FS has not defined the nature and extent of contamination. Offpost investigations must be broadened to include an assessment of all media which could be exposure pathways to humans.

Response:

We are not in agreement with the first sentence of this comment. Although significant contamination has been documented onpost in the Denver Formation, existing onpost water quality and hydrologic data clearly indicate that the alluvial aquifer is the "primary pathway for contaminant releases from RMA". However, a substantial amount of effort has been devoted to defining the level and extent of Denver Formation contamination offpost.

All available data, including the offpost CAR, clearly document that the dominant pathways for release of contaminated from RMA are by ground water and surface water. The referenced statement implies nothing about the variety of exposure pathways which may operate after release. All media which could be exposure pathways to humans will be addressed, as stated in the referenced plan, and amplified upon in our general response.

Comment 43: Page 9-2

The endangerment assessment (EA) proposed in Task 39 is substantially incomplete; is biased in that it evaluates only one contaminated media (water); does not evaluate

the entire affected offpost study area; does not address the impact from existing RMA contamination of public and private drinking water supply wells; is inconsistent with the EPA Superfund Public Health Evaluation Manual procedures and guidelines for conducting such assessments; and is of limited value to the complete RMA RI/FS. The Task 35 and Task 39 EAs should be consolidated.

Response: The statements in the first sentence of this comment are incorrect. The only basis upon which we can understand such a complete misinterpretation of our plan relates to its brevity. The Task 35 plan addressed only the EA activity onpost. The Task 39 plan addresses RI, EA, and FS activities, and the description of the EA activity was abbreviated because there is not as much RI data on the offpost area as was available onpost during preparation of the Task 35 Technical Plan. However, as clearly stated on page 9-1 the assessment will be conducted in accordance with all relevant guidance documents to be similar in scope and levels of detail with Task 35. The latter statement was intended to incorporate by reference methods presented in the Task 35 plan where that plan is relevant to the contaminants, contaminated media, population at risk, and exposure pathways encountered in the offpost study area.

Comment 44: Pages 9-5 to 9-9

The PPLV criteria and standards being developed in Task 35 will not be "final" or available for use given the projected schedule of the proposed offpost EA. Please explain.

Response: The priority pollutant limit values (PPLV) criteria developed in Task 35 address soil contamination in areas with substantially different land use than the offpost

study area. For that reason they are not relevant to, or needed to conduct the offpost EA. The PPLV criteria discussed in this plan address contaminated media (surface water and ground water) relevant to, or needed to conduct, the offpost study area EA and will consider exposure pathways that result from the use of these media.

Comment 45:
Page 10-4

The discussion of the application of CERCLA Section 121 in the text is incomplete and should be corrected. The text should note that the selected remedial action must assure the protection of human health and the environment. In addition, the report should state that Section 121 requires a level or standard of control which at least attains Maximum Contaminant Level Goals (MCLGs) established under the Safe Drinking Water Act and water quality criteria established under Section 304 or 302 of the Clean Water Act considering the designated or potential use of the surface and ground water. The designated potential use of the Alluvial aquifer is as the principal drinking water supply for the current and future residents of South Adams County.

Response:

The selection of a remedial action will assure the protection of human health and the environment and meet the requirements of Section 121 as they apply to the offpost operable unit.

Comment 46:
Page 10-6

The statements in the text that, "based upon current data, soils air and biota are not anticipated to require remedial actions, and that "they will, however, be fully investigated" are inaccurate. No "current data" are available for air and offpost biota. Only very limited data is available for soils contamination. Please identify which data were used to arrive at this

conclusion, and which proposed RI program "fully investigates" these potential pathways.

<u>Response</u>: We agree with the comment regarding the referenced statement, and it will be changed in the text.

The approach to be used in the EA to assess soils as a potential exposure pathway was addressed in our response to comments #2 and #3.

Task 18 has characterized regional air quality as well as evaluating onpost sources of airborne contaminants. An inventory of potential offpost airborne sources will be conducted during Task 39. If required, air sampling and analyses will be proposed.

Assessment of Biota in the offpost areas will be integrated with Task 9, the onpost/offpost Biota Assessment. All relevant data from Task 9 will be incorporated into the offpost EA to ensure that potential pathways are examined.

<u>Comment 47</u>: Pages 10-1 to 10-24

The Feasibility Study (FS) "plan" for Task 39 is essentially a reiteration of the current guidance documents and statutory requirements with little or no specificity to RMA. RMA Onpost (Task 28) and Offpost (Task 39) FS plans <u>must be</u> specific to RMA. The tasks should be consolidated into a single FS effort to avoid duplication.

<u>Response</u>: At the current time, making the FS plan more specific would be premature. All the information gathered in the RI will be utilized in defining the FS. Mentioning guidance documents and statutory requirements outlines

the process that will be taken to determine the most appropriate remedial action.

The Task 39 FS should not be consolidated with the Task 28 FS because certain parameters such as: land use, cleanup levels, quantities, technologies, and timeframe may differ. By handling the FS separately it will ensure that the remedial actions that are developed are specific to the area, the operable units, and types and levels of contaminants.

<u>Comment 48</u>: Page 10-16

Please elaborate in the text on the statement in the report that: "In many cases, no relevant ARARs are likely to be available for the compounds found offpost of RMA."

<u>Response</u>:

For many of the hazardous substances, pollutants or chemicals found in the past in the Offpost Operable Unit, there are not presently any existing Federal or State applicable or relevant or appropriate standards, requirements, criteria or limitations (ARARs). However, this does not mean that the RI/FS will refrain from setting clean-up limits for these chemicals, but only that such limits will be the product of the Offpost Endangerment Assessment rather than result directly from the application of ARARs.

<u>Comment 49</u>: Pages A-1 to A-9

The use of unilaterally established "water quality guidance levels" to depict the data on the figures is inappropriate. Numerical presentations should be used. These figures should be modified or deleted from the text.

<u>Response</u>:

A clarification of the intended use of "water quality guidance levels" has been provided in our response to

Comment #10. Since these levels do provide an indication of the "level" of contamination, the figures in Appendix A do provide a graphic depiction of significant contamination in the offpost area. This was the intention of these maps, and they will remain in the text to serve this purpose.

RESPONSES TO
SHELL OIL COMPANY COMMENTS ON THE
TASK 39 DRAFT FINAL TECHNICAL PLAN
MAY 1987

General Comments

Comment 1: Contamination of the Denver Formation needs to be assessed. A comprehensive sampling of wells screened in the Denver Formation should be included in Task 39. Since this does not appear to be possible given the current well distribution, the proposed cluster wells described in Section 2.0 should be installed. All of the proposed wells should be placed on the high priority list. These wells should not be proposed solely upon the assessment of upgradient conditions if there are currently no wells upgradient to be assessed.

The plan states that contaminants have been detected in samples taken from wells screened in the Arapahoe aquifer. The location and construction information of these wells should be included, and continued sampling of the Arapahoe should be proposed.

Response: The following is a list of sites where wells are installed and/or deep borings have been drilled downgradient of the North Boundary Containment System (NBCS) under Tasks 25, 36, 39, and 44:

Site	Activity	Task
E-32	Deep Boring 1st Denver Sand 2nd Denver Sand	36
E-33	Deep Boring 1st Denver Sand	36
E-34	Deep Boring 1st Denver Sand	36
E-38	Alluvial Deep Boring 1st Denver Sand 2nd Denver Sand	39

E-39	Alluvial Deep Boring 1st Denver Sand 2nd Denver Sand	36
E-40	Alluvial Deep Boring 1st Denver Sand 2nd Denver Sand	36
E-42	Alluvial	
E-46	Alluvial Deep Boring	39
E-47	Alluvial Deep Boring	39
E-55	Alluvial	25
E-63	Alluvial Deep Boring 1st Denver Sand	36
E-64	Alluvial (dry)	39
E-65	Alluvial	39
E-67	Alluvial	25
E-69	Deep Boring	36
E-73	Alluvial Deep Boring	39
E-74	Alluvial Deep Boring	39
E-75	Alluvial (dry)	39
EP-19	Deep Boring	36
EP-20	Deep Boring 1st Denver Sand	36
EP-21	Deep Boring	36
EP-28	Deep Boring	36
EP-72	Alluvial Deep Boring 1st Denver Sand 2nd Denver Sand	44

The locations of these sites are shown in the Composite Well Drilling Program. The sites provide a network with which to examine Denver Formation geology, flow rates and directions, and water quality. As noted from the list above, many of these sites are being drilled under tasks other than Task 39.

DIMP was the only organic contaminant detected in the two Arapahoe wells mentioned in the Technical Plan. Both of these wells had levels of DIMP near the Certified Reporting Limit. Periodic monitoring of these wells is presently being considered by the Army to ensure that consumption of water from these wells poses no threat to public health. The location and construction information of these wells is available upon request.

<u>Comment 2</u>: The report is weak in its description of the hydrogeologic characteristics of the lithologic materials in the study area. Aquifer tests have been completed in the vicinity of the North Boundary. Approximate hydraulic conductivities can be assigned to the materials in this area and corresponding velocities can be calculated. These should be included in the hydrogeologic description of the study area.

<u>Response</u>: The subject technical plan is not a report and was not intended to provide a lengthy hydrogeologic discussion. Much of the hydrogeologic characterization of aquifers in the study area is being performed under Tasks 36 and 39. Preliminary hydraulic characteristics of the offpost aquifers were evaluated in the Offpost Contamination Assessment Report (CAR) (ESE, 1987). A primary objective of Task 39 is to obtain more detailed hydrogeologic data and to characterize the aquifer in the offpost area. The findings of the present studies are available upon request and will be incorporated into the Task 39 Final Report.

Comment 3: The contaminant distribution maps presented should be analyte specific. This will help in visualizing the locations of contaminants. The manner in which the maps are presented raises questions as to whether some or all of the analytes grouped on the maps are present in the indicated wells.

Response: The contaminant distribution maps were obtained from the Offpost CAR. The purpose of the maps is to provide an introduction to contaminant concentrations and patterns in the offpost area. More specific data is available in the Offpost CAR and will be provided in the final report.

Comment 4: A sampling schedule of the Revision II 360 Monitor Program should be included if these wells are to be continuously sampled.

Response: Wells from the Revision III-360^{o} Monitoring Program have been incorporated into the Task 44 Monitoring Program and the comprehensive monitoring program and the sampling schedule for Task 44 will be made available in the Draft Final Technical Plan. Monitoring to be conducted after November, 1987 will be included in the Comprehensive Monitoring Program. Scheduling will be made available to the OAS parties prior to implementation in the field.

SPECIFIC COMMENTS

SECTION 1.0

Comment 1: Page 1-6, Top of Page

DIMP is singled out as possibly not a "hazardous substance, pollutant, or contaminant" whereas all other organic compounds are noted to be "organic contaminants." By what reasoning is DIMP excluded other than it is the most widespread Army compound found offpost?

Response:	Available data presently indicates that DIMP comes within the definition of "pollutant or contaminant" in CERCLA Section 101(33), 42 U.S.C. Section 9601(33), although not within the meaning of "hazardous substance" as defined in that section. The text will be revised accordingly to reflect that DIMP is a CERCLA "pollutant or contaminant".
Comment 2: Page 1-7	Is there more than one shallow aquifer in the study area? The sentence leads one to believe that there are multiple shallow aquifers.
Response:	This statement refers to the alluvial aquifer and uppermost Denver sandstone units near the NBCS.
Comment 3: Page 1-7, Paragraph 1.2.2	The way the Northwest Boundary is described it is not possible for the uninformed reader to ascertain that half of the boundary is a hydrologic control system similar to Irondale Boundary Control System.
Response:	The description of the Northwest Boundary Containment System (NWBCS) will be supplemented for purposes of clarification.
Comment 4: Page 1-11, Top of Page	The text indicates that the O'Brian Canal and Burlington Ditch intersect Second Creek. Yet Figures 1.3-1 and 1.3-2 indicate that Second Creek continues to the South Platte River.
Response:	Water from First Creek and Second Creek flows into O'Brian Canal. (This canal is called Burlington Ditch upgradient before it splits into O'Brian Canal and Burlington Ditch.) The Second Creek drainage continues to the South Platte, but all upstream flow is intercepted by O'Brian Canal. The text of the Technical Plan will be supplemented to clarify these facts.

Comment 5: Page 1-11	The reported precipitation values seem very high for this climate. A value of 15 inches per year seems more realistic than 76 to 102 inches.
Response:	The annual precipitation value in the Draft Technical Plan is in error. We agree that 15 inches per year is a reasonable estimate. The text will be corrected to reflect this fact.
Comment 6: Page 1-17	Please specify whether the description of the thickness of the surficial deposits is restricted to offpost areas. The water-bearing units of the Denver Formation are not restricted to sandstones - the transmissible units may be sandstone, but the other lithologies are saturated.
Response:	The description of the thickness of the surficial deposits is not restricted to offpost areas but is provided as an overview of onpost and offpost conditions at RMA. "Water-bearing units" was used to refer to a unit can transmit or bear economic quantities of water. We agree that other lithologies of the Denver are saturated.
Comment 7: Page 1-19	The last paragraph appears out of place. This paragraph should be included with the description of the surficial deposits. The sections would read more clearly if a geologic description was presented first, followed by a hydrogeologic description.
Response:	We are in agreement that the last paragraph of page 1-19 and the first paragraph of page 1-20 should be included with the description of the surficial deposits. This change will be made in the text.

Comment 8: Page 1-22	A map showing the distribution of the sampled wells should be presented for each of the programs. The way in which the figures are presented leads the reader to believe that the same wells were sampled during each program; this is not the case.
Response:	The locations of wells sampled in the Consumptive Use - Phase I, Consumptive Use - Phase II, and Revision III - 360° monitoring programs are shown in the final reports of those programs. These reports are cited in the Technical Plan as Rocky Mountain Arsenal Offpost Contamination Assessment - Ground Water Quality Report for Sampling Period, December 1984 through January 1985 (ESE, 1985c); Rocky Mountain Arsenal Offpost Assessment - Ground Water Quality Report (Consumptive Use - Phase II) for Sampling Period, September 1985 through October 1985 (ESE, 1986b); and Continued Offpost Ground Water Monitoring Program (Revision III - 360° Monitoring Program) (ESE, 1986c).
Comment 9: Page 1-23, Table 1.4-1	Previous comments were provided the Army as part of our comments on the PPLV technology (December 1986).
Response:	These comments were received, responded to by the Army, and incorporated into the Technical Plan.
Comment 10: Page 1-23	The detection limit for DIMP is listed as 10.0 ppb in the text but is listed as 11.0 ppb on Figure 1.4-1. Which is it? The years over which the samples were collected should be noted on the figures or explained in the text. As it is, the reader must be familiar with each of the sampling programs.
Response:	In reality, both of these values (10 ppb and 11 ppb) refer to the same Certified Reporting Limit of 10.5 ppb

for DIMP. One value was rounded up and the other rounded down. The text will be revised for consistency. The dates of the sampling programs will be supplied in the text.

Comment 11: Page 1-29

The first paragraph is confusing. Are the results from the Phase I and II consumptive use programs being compared to the results of the Revision III 360 Monitor Program? The contaminants have migrated further than what?

Response:

The first paragraph on page 1-29 is intended to provide an introductory description of contaminant distributions in the offpost area. By examining several of the data from the Revision III-360° Program, these contaminants appear to have migrated over a mile from the RMA boundaries. The language in the text will be modified to make this paragraph clearer.

Comment 12: Page 1-30

The locations and construction information of all sampled Denver Formation wells should be included.

Response:

The locations of bedrock wells sampled in the Consumptive Use-Phase I and Revision III-360° Monitoring Programs are given in the respective program reports. The details on construction of any of these wells are available upon request.

Comment 13: Page 1-30

When were the surface water samples collected? Why isn't additional surface water sampling proposed?

Response:

Quarterly surface water samples have been collected at the stations noted since December 1985. Since December 1986, these quarterly samples have been collected under Task 44. Although these samples are not being collected under Task 39, the data obtained will be incorporated into the offpost Remedial Investigation/Feasibility Study (RI/FS).

Comment 14: Page 1-30, paragraph 1	In the last sentence it is inferred that the flow is from the alluvial to the Denver aquifers on the RMA. This would indicate that the Denver Formation on the RMA should be more contaminated than the sampling has indicated to date. Can you explain the apparent discrepancy between the statement and the results?
Response:	The data available show that the potential for flow from the alluvium to the Denver Formation does exist in many areas onpost. The potential for upward flow onpost, primarily where Denver sandstones subcrop into the alluvium, also exists. The degree to which contaminants are present in the Denver depend on the magnitude of vertical gradients, the solute transport characteristics of the individual contaminants, the hydraulic conductivity of the Denver Formation lithologies, and many other factors. Therefore, it is difficult to respond to this comment without consideration of the other complex factors involved and evaluation of specific hydrologic and water quality data. Because Task 44 is specifically geared to address these questions, this comment is most appropriately addressed under that program. Task 39 will focus on addressing this comment in the Offpost Operable Unit.
Comment 15: Page 1-30, Paragraph 1.4.3	What is the basis of stating that "ground water discharge to surface water bodies is probably a major migration pathway in the study area"? Specifically what water bodies are inferred?
Response:	Describing this pathway as major may be overstating the facts. However, this comment is primarily referring to ground water discharge into First Creek in Sections 13 and 14 in the offpost area. This statement is based on gaging at First Creek at the RMA boundary and at Highway 2. These data have shown that First Creek gains water between these two known flow points at different times during the year. These data are verified by the fact

that historic and recent water table elevations are above the bottom of First Creek at many points in Sections 13 and 14 when there is no base flow in First Creek.

Comment 16:
Page 1-33,
Paragraph 1

Just as analytical interferences may be a rational explanation for the detection of DIMP near the detection limit, the same could be true for other organics. However, none of the other reports have advanced this explanation until DIMP was found in unlikely locations. Why is this explanation offered only in the case of DIMP? Note that this was not offered as an explanation in the very next paragraph.

Response:

The explanation for the detections of DIMP was given because both of the sample locations are upgradient from source areas at RMA. While this explanation could apply to other organic contaminants detected in surface water, these detections were downgradient of RMA and there are plausible pathways by which these contaminants could reach the sampling points.

APPENDIX A

Comment 17:
Page A-1

A < symbol is shown, this should be a > symbol.

Response:

Figure A-1 has been corrected to reflect your comment.

Comment 18:
Page A-2

Does this figure represent first or second quarter findings?

Response:

This figure was incorrectly labeled as a first quarter sampling. The title block on this figure will be changed to indicate a second quarter sampling.

Comment 19:
Page A-4

Same comment as above.

Response: This figure was incorrectly labeled as a first quarter sampling. The title block on this figure will be changed to indicate a second quarter sampling.

Comment 20: Page A-6

Same comment as above. The figures should be analyte specific, the year during which samples were collected should be noted, a plot of the sampled locations (well # and alluvial or Denver Formation designation) should be included.

Response: This figure was incorrectly labeled as a first quarter sampling. The title block on this figure will be changed to indicate a second quarter sampling. The figures presented in Appendix A are shown to provide an overview of offpost contamination. More detailed information, including well number and formation sampled, is available from the Offpost CAR. The specific dates corresponding to the sampling events are December 1985 through January 1986 for the first quarter and March 1986 through April 1986 for the second quarter. These dates will be included in the text for clarification.

APPENDIX C

Comment 21: Data sheets appear adequate.

Response: No response required.

SECTION 2.0

Comment 22: Page 2-2, Figure 2.1-1

The location of the wells in reference to previous interpretation of the contaminant plumes and the top of the bedrock would assist the reader in understanding the logic to the location selected. Is there a well designated as E-37 located near the Boller's well in addition to the well labeled E-37 in this figure.

Response: The Army well nearest the Boller well is at Site E-31 and is numbered 37344. E-37 refers to another site.

More detailed rationales for well siting and the relationships between well location, contaminant plumes, and the bedrock surface are provided in the Composite Well Drilling Program.

Comment 23: Page 2-3

Does Task 36 include additional Denver Formation wells not described in this task?

Response:

Task 36 includes several wells completed in the Denver Formation offpost and right along the north boundary which are not described in the Task 39 Technical Plan. These wells are shown in the Composite Well Drilling Program and in the Task 36 Technical Plan.

Comment 24: Page 2-6

Which Denver Formation wells will be sampled upgradient from the study area? These should be listed.

Response:

As indicated in our previous response, several Task 36 Denver Formation wells have been installed along the RMA North Boundary. These wells will be sampled to provide water quality data on the Denver Formation just upgradient from the study areas. Additionally, existing and newly installed Denver Formation wells will be sampled near the North and Northwest boundaries under Task 25 to substantiate water quality upgradient of the study area. These wells are denoted in the Tasks 25 and 36 Technical Plan.

Comment 25: Page 2-8

If Site E-46 is used to define a bedrock channel, how can Site E-47 be used in lieu of this well? These sites are 1,200 feet apart. Most of the paleochannels in the study area are not wide. What Denver Formation wells will be sampled upgradient to determine if a cluster well system will be installed?

Response:

Alluvial wells have been installed at Sites E-46 and E-47. In addition, wells have been installed at E-73 and E-74 along this east-west line. All of these sites are

shown in the Composite Well Drilling Program and are being used to define alluvial geology and bedrock configuration. Denver wells at E-32, E-33, E-34, and E-63 are being sampled upgradient to determine water quality and the possible need for additional Denver Formation monitoring at E-46, E-47, E-73, and E-74. Locations for all of these sites are shown in the Composite Well Drilling Program.

Comment 26: Page 2-9

Where is the Boller well located in relation to proposed Sites E-53 and E-58. The Boller well should be plotted on the map.

Response:

The location of the Boller Well will be shown on Figure 2.1-1.

Comment 27: Page 2-10

The purpose of the proposed Bore E-43 should be explained. It appears that information from this bore would further define the bedrock surface. This should be a high priority bore.

Response:

The proposed Bore E-43 was permitted to further define the bedrock surface and alluvial geology. However, historic upgradient ground water quality data has shown little or no contamination in this area. The need for obtaining geologic data at this site will be based upon additional water quality data from high priority offpost sites and upgradient sites under Tasks 25 and 36.

Comment 28: Page 2-11

Sites E-36 and E-49 should be considered as high priority sites. These bores would further define the bedrock surface in an area where little data exist.

Response

We agree that Sites E-36 and E-49 would further define the bedrock surface in an area where little data exist. However, these sites are substantially to the east of the significant alluvial contamination documented near the RMA North Boundary and are considered lower priority

than sites closer to the middle of Section 13 based on the local ground water flow patterns.

<u>Comment 29</u>: Page 2-15, paragraph	We need to determine which wells and from which levels we desire to obtain split samples. If we could ascertain this now, the Army would have no excuse for not cooperating.
<u>Response</u>:	It is unclear what Shell intends to accomplish with this comment. If additional information on sampling locations, screened intervals, and frequencies is being requested, we are more than willing to provide all of these data upon request. If split samples are being requested, this also can be accomodated. We welcome any meetings Shell would like to propose to further coordinate the field activities.
<u>Comment 30</u>: Figures 2.4-2 through 2.4-9	What is installed at the bottom of the casings in these wells? Are they capped? The screened interval should be labeled as such. Why are the cluster wells proposed to be 20 feet apart in Figure 2.4-9?
<u>Response</u>:	The bottom of the casings of all wells will be capped with flush threaded caps. This detail will be addressed for Denver wells on an appropriate drawing in the Technical Plan. The screened interval in the referenced figures is shown by horizontal lines in the lower portion of the wells. The 20-ft distance between wells has been specified to allow adequate access for drilling equipment. However, 20 ft is used as an arbitrary distance and may vary depending upon specific site conditions.
<u>Comment 31</u>: Page 2-28	Temperature of the groundwater should be measured prior to pH and conductivity.

Response: pH meters used in the field are equipped with built-in temperature probes so that pH and temperature can be measured simultaneously. Conductivity is measured as specific conductance with all values compensated to 20^{o}C. This practice eliminates any variances in conductivity data due to temperature differences.

Comment 32: Page 2-29
The materials generated should be analyzed to insure that they contain no contaminants. No assumptions should be made.

Response: Waste handling activities are being performed to be consistent with the Task 32 Technical Plan, RMA waste handling, which is being conducted by EBASCO, Inc. The technical guidelines for this task were established to incorporate guidance from the EPA. (EPA Letter, Appendix Back of Task 32).

Comment 33: Page 2-30, Top of Page
The guidelines in Task 32 have yet to be discussed with the MOA parties. When is this going to occur?

Response: This comment refers to waste handling procedures covered under Task 32 which is being performed by EBASCO. The specifics of these procedures should be addressed in responses to comments on that task.

SECTION 3.0

Comment 34: Page 3-1, No. 3
Organic vapor analyzer (OVA) may register high readings when the HNU does not. Also there may be high concentration of dissolved metals in ground water. Lack of HNU is not a sufficient basis for discharging water onto the ground.

Response: The HNU is appropriate to pick up the majority of volatile contaminants found in offpost ground water. One contaminant, chloroform, is more effectively detected by an OVA. However, based on review of offpost

ground water quality data, high concentrations of chloroform are uncommon. The proposed means of disposing of water discharged from pumps and bailers is consistent with guidance provided by EPA in a letter from Mr. Robert Duprey to Colonel W.N. Quintrell, dated July 19, 1985. The Army will comply with this guidance so as to protect both field personnel and the environment.

Comment 35:
Page 3-2, No. 1

The well must be sampled within 24 hours of purging. The measurement of pH, conductivity and temperature is performed for each bailer load or once for each well during sampling.

Response:

All wells are sampled within 24 hours of purging. Wells that are slow to recover are sampled as soon as possible within the 24-hr limit. Time, pH, temperature, and conductivity are measured after the removal of each well volume.

Comment 36:
Page 3-2, No. 2

What is the justification for single rather than triple rinse? What quantity (i.e., 1/3 or 1/2) of containers is deemed sufficient for rinse? Is rinse for sample bottles "decanted" directly from the bailer or from the container used to measure temperature, Ec, pH?

Response:

A single rinse is considered adequate because the sample containers are cleaned and custody sealed by the laboratory prior to sampling. Current protocol calls for sample bottles to be rinsed with a portion (approximately 1/3 to 1/2 of the container) of well water directly from the bailer or sampling pump.

Comment 37:
Page 3-3,
Section 3.2, No. 1

Are all samples filtered? They should be filtered as necessary.

Response:	Only samples that are analyzed for dissolved metals are filtered in the field. Samples are filtered through 0.45 micron filter and preserved with nitric acid. This procedure is necessary to prevent precipitation that occurs at upper pH ranges.

SECTION 4.0

Comment 38: Page 4-2	Duplicate target analyte p,p'-DDE in Table 4.0-1.
Response:	The duplicate of "p,p'-DDE" will be deleted from Table 4.0-1 and p,p'-DDT will be included.
Comment 39: Page 4-2	Organochlorine pesticides/organo-sulfur compounds should be analyzed for no more than 40 days after extraction.
Response:	The organochlorine pesticides/organosulfur compounds are to be analyzed within 30 days of extraction. This is within the 40-day period stated in your comments and required by EPA methods.
Comment 40: Page 4-3, Table 4.0-1	EPA Method 608 references organochlorine pesticides by GC/EC and not appropriate for DCPD and MIBK.
Response:	USATHAMA Method R-8 is being used for DCPD and MIBK. This method will be noted in the Technical Plan and reference to EPA Method 608 will be deleted.
Comment 41:	Table 1.4-1 and 4.0-1 are not complimentary. Analytes listed in Table 1.4-1 but missing in 4.0-1: o Toluene o Benzene o Xylenes o Ethylbenzene o pH o Electrical Conductance

Analytes listed in Table 4.0-1 but missing 1.4-1:

- o Chlordane
- o MIBK

Response: All of the analytes mentioned in your comment are being analyzed for in Task 39. Table 4.0-1 will be updated to reflect the complete laboratory analyte schedule. Electrical conductance and pH are not included in Table 4.0-1 because they are measured in the field. Table 1.4-1 has been deleted from the text.

Comment 42: Page 4-3, Table 4.0-1

No holding times mentioned for inorganic constituents except for calcium.

Response: Holding times for all the specified inorganic constituents will be added to the text of the Technical Plan.

Comment 43: Page 4-2

Not appropriate to mention EPA reference; the USATHAMA method number should be stated in Table 4.0-1.

Response: The USATHAMA method number will be specified in lieu of the EPA reference for all analytes listed in Table 4.0-1 and the volatile aromatics.

Comment 44: Page 4-3

1) Why is the Level of Certification for DIMP/DMMP qualitative and not quantitative?
2) No description of GC verification/confirmation protocols.
3) What unknowns from past GC/MS procedures have been incorporated into methods for GC/CD analyses other than benzothiozole. Why isn't benzothiazole a target analyte?
4) Table 1.4-1 and the Introduction to Section 4.0 indicate that five volatile aromatics will be addressed. The five volatile aromatics omitted from Table 4.0-1 are:

- o m-Xylene
- o Benzene
- o Ethylbenzene
- o Toluene
- o Xylene (o/p)

5) ESE-GV and ESE-Denver are certified for a GC/PID method for the aforementioned compounds. Why are these compounds not included in Table 4.0-1?

6) What is the criteria used to select the target analytes for this task? It is based on risk assessment? Why haven't any agent degradation chemicals been added to this target analyte list such as:

- o thiodiglycol
- o thiodiglycolic acid
- o chloroacetic acid
- o isopropylmethyl phosphonate
- o methyl phosphonic acid
- o fluoroacetic acid

7) Has the EPA given approval to the analyte list and methodologies for this task in the event that EPA assumes lead responsibility for the offpost RI/FS?

Response:

1) The level of certification for DIMP/DMMP is quantitative. This change will be made to the text of the Technical Plan.

2) For organochlorine pesticides, confirmation of peak identity was accomplished not only by comparison of sample retention time with retention times of standards, but also with a second different GC column. For all other GC analytes, peak identity was established by comparing sample and standard retention times.

3) Addition of nontarget analytes to the target analyte list is a continuing process. Currently, GC/MS screening data are under review by the Army

to consider the addition of analytes to the target list. Chlordane has been added to the target list for the offpost RI. Also, benzothiozole was included but inadvertently left off Table 4.0-1 in the Technical Plan.

4) The five volatile aromatics specified in Table 1.4-1 will be included in Table 4.0-1.

5) The five volatile aromatics will be included in Table 4.0-1 and analyzed by GC/PID.

6) The target analyte list for the Offpost RI/FS was developed based on data collected from the onpost monitoring program. To be considered for inclusion on the offpost analyte list, the compound must have been detected onpost and, based on the distribution, been determined to be migrating toward the boundaries of RMA. The analyte list for the offpost then consists of compounds that have migrated offpost or that are likely to in the future. Each of the agent degradation compounds listed in this comment have either not been detected onpost or the distribution of detections onpost does not indicate contaminant migration.

   In addition to the target analyses completed for the offpost samples, nontarget GC/MS scans have been completed on samples from most of the offpost monitoring wells in attempt to identify additional compounds that may warrant inclusion on the target analyte list. To date, no compounds have been identified from the GC/MS for inclusion on the list.

7) EPA has reviewed the analyte list for the Offpost RI/FS as part of the Task 39 Technical Plan and did not provide any comments regarding the inadequacy of the target list.

SECTION 5.0

No comments.

SECTION 6.0

Comment 45: Page 6-4, No. 3

"Total organic" vapors as reported by HNU does not reflect compound toxicity. 5 ppm in the breathing zone may or may not be prudent or compatible with APR for extended periods of time. Also detection response is relative to calibration.

Response:

ESE approaches the use of personal protective equipment (PPE) including air purifying respirators (APR) conservatively when working on sites with the wide range of organic compounds like RMA. This conservative approach is reflected in the ranges of total organic vapor concentrations ESE uses for determining the level of personal protection. These ranges are also recommended by the EPA for assisting in the selection of PPE.

ESE uses NIOSH/MSHA approved respiratory equipment and cartridges. These cartridges are approved for up to 1,000 ppm organic vapors. However, because of the wide range of compounds encountered, the varying sensitivities of the detection instruments to the different compounds, and possible breakthrough of compounds when acting together, ESE has set a 5 ppm upper limit for the use of APR's. ESE feels that APR's will adequately protect field personnel from organic vapors from the background to 5 ppm level.

SECTION 8.0

Comment 46: Numbers 1 and 2

The additional borings, apparently those shown in Section 2.0, are said to penetrate the Denver Formation to the 1st and 2nd sandstones. It is questionable whether this is deep enough for confident correlation to Denver units inside the RMA, because individual sandstone lenses are not correlatable with confidence.

Response: Deep borings are being drilled to an average depth of 100 to 120 ft. At this depth, these borings generally extend below the third sandstone encountered at the site. Wells are initially being installed in the upper Denver units. The justification for this methodology is that the upper units are more likely to show contamination than lower units based upon an evaluation of the regional hydrogeology.

Confident correlation of Denver units offpost with the onpost is primarily dependent upon obtaining an adequate areal distribution of borings. Correlations are only dependent on depth to the extent that boreholes must be deep enough to intersect the onpost sandstones of interest. Since these sandstone units are generally updip to the northwest, offpost borings should at a maximum be drilled to depths comparable to the depth of onpost borings. In all cases, preliminary geology cross-sections are prepared before drilling to ensure that borings are deep enough to intersect the Denver units being correlated.

Comment 47: Section 8.0, Numbers 3, 4, and 5

The aquifer tests referred to are in the alluvium only. It is questionable whether this is sufficient to interpret groundwater flow in the Denver Formation. There appears to be no mention of examination of flow across the alluvium/bedrock contact in the aquifer tests, i.e., will there be Denver Formation observation wells?

Response; Interpretation of flow within the Denver Formation will be performed based upon previous aquifer tests (pumping and slug tests) and additional slug tests to be conducted on newly installed Denver wells. Hydraulic conductivity values obtained from these tests will be used in conjunction with piezometric data from

correlatable sandstone units to estimate flow within the Denver Formation.

Quantitative analysis of vertical flow based on evaluation of alluvial aquifer tests, while measuring piezometric response in the Denver Formation, is quite complex. It is doubtful that this type analysis would provide meaningful data on vertical flow between the alluvium and the Denver because of the highly variable hydraulic properties of the upper Denver "aquitard" and the slow or nonexistent responses that can be expected in Denver piezometric levels. Vertical flow will be evaluated by examining ranges of hydraulic conductivity for the types of materials commonly found in the upper Denver Formation and correlating these values to the geologic conditions encountered at specific sites.

SECTION 9.0

Comment 48: Page 9-1, Paragraph 1 — The reference citations are incomplete.

Response: Complete citations will be provided for all references in the Final Technical Plan.

Comment 49: Page 9-1, Paragraph 2 — The use of the onpost EA for technical consistency with the offpost EA raises the following questions:

1) Will the technical problems of the onpost EA (see Shell comments to Army, March 24, 1987) be transferred to the offpost EA?
2) Since the onpost EA focuses remediation of soils and the offpost EA focuses on groundwater and surface water, how will technical consistency due to intermedia differences be maintained?
3) Since the onpost EA uses the rural residential land use scenario, and since Adams County currently has a variety of land uses other than the rural

residential land use scenario as proposed in the Army's onpost EA, why is it appropriate to achieve technical consistency betweent he onpost and offpost EAs with respect to land use scenarios?

4) What future land use and exposure assumptions are being incorporated for the offpost EA?

Response:

1) We are not aware of technical problems with the onpost Endangerment Assessment (EA). We expect that perceived technical problems will be resolved offpost in similar fashion to that achieved onpost.
2) Consistency will be achieved in any common areas such as toxicity assessment and fate and transport fundamentals.
3) A variety of land uses will be evaluated in the offpost EA. Technical consistency between the onpost and offpost EAs will be achieved for any land use scenarios in common between the onpost and offpost areas
4) Exposure assumptions will be generally consistent with the guidance contained in the Superfund Exposure Assessment Manual, and future land use will be based on input from the Census Bureau and local planning agencies.

Comment 50:
Page 9-1,
Paragraph 3

When the Army presents its recommended water quality criteria to the MOA parties, Shell expects that the Army will have previously discussed with the MOA parties the comments that have been received on the PPLV process, chemical compounds of concern and other health and risk assessment related comments. It is not realistic for the MOA parties to reply to the Army recommendations in a short period of time as the Army has not responded to our previous comments in this area.

Response:

These items are being discussed in the RMA "How Clean is Clean" Task Group which includes representatives of the Organizations and the State (OAS).

Comment 51: Page 9-2, Paragraph 2	The level of detail (as suggested in the Endangerment Assessment Handbook) is not provided.
Response:	The level of detail for the offpost EA is most appropriately described as a Level 3 Endangerment Assessment as described in the Endangerment Assessment Handbook.
Comment 52: Page 9-2, Paragraph 1	The following ambiguous statement is made: "Contaminants exhibiting a spatial pattern similar to contaminant which have been documented to have migrated across the boundary." This statement should be clarified, and a reference citing the need to perform this activity should be provided. How does the "How Clean is Clean" Committee interface with the four separate components listed in this paragraph?
Response:	It has been assumed in planning stages that additional contaminants may be observed offpost that were not expected based on contaminants observed at the boundary. If such contaminants were found exclusively in areas of documented Arsenal contamination, then an association with the Arsenal would have been established. Preliminary offpost contamination assessment results have not revealed such contaminant spatial patterns. The "How Clean is Clean" Committee has closely guided the toxicity assessment. In the remaining three components, the offpost EA is based on methodology previously approved by the Committee in situations where the contaminants and pathways are similar to onpost.

Comment 53:
Page 9-2,
Paragraph 9-1

Why isn't the Army considering resolution of the different proposals received on identifying the contaminants of concern rather than listing the criteria found in this paragraph?

Response:

Resolution will be achieved in the context of Task 35 (onpost EA) and the RMA "How Clean is Clean" Task Group.

Comment 54:
Page 9-2,
Paragraph 4
and Page 9-3,
Paragraph 1

The following two statements should be clarified: "Contaminants found offpost which have been documented to have been associated with RMA onpost activities" are to be identified, and deletion of contaminants from a listing of contaminants of concern because "[C]ontaminants found offpost which could not result from onpost activities." As presented, these statements infer that RMA chemicals are "guilty by association" for the offpost contamination, but with questionable documentation procedures. Also, this section does not describe what procedures will be used to incorporate the naturally occurring background levels of contaminants into the contaminant identification process. Finally, the health effects of a contaminant of concern should be considered before deleting the contaminant from the listing due to the lack of association to onpost activities.

Response:

The inference stated in the second sentence of the comment is incorrect and is not logically based on the referenced Technical Plan. A discussion of the method for accounting for natural background levels will be added to the revised Technical Plan. Essentially, groundwater concentration within a range observed at sites upgradient or having no plausible pathway from Arsenal sources is assumed not to be contamination resulting from a release under the definition of SARA.

The health effects are considered through the comparison with hazard criteria as stated on page 9-3, paragraph 1.

<u>Comment 55</u>: Page 9-3, Paragraph 1

How is the applicable "hazard criteria" determined at this stage of the EA?

<u>Response</u>:

The applicable "hazard criteria" are determined from applicable or relevant and appropriate requirements (ARARs) and consistent with the toxicity assessment, the Superfund Reauthorization Act of 1986 (SARA), and the Superfund Public Health Evaluation Manual.

<u>Comment 56</u>: Page 9-3, Paragraph 2

Justification should be provided for not following EPA recommendations to perform an indicator contaminant screening.

<u>Response</u>:

The plan will be revised to include an indicator contaminant screening step to prioritize efforts. All offpost contaminants, however, will be addressed in the EA. Indicator contaminants will be addressed in greater detail.

<u>Comment 57</u>: Page 9-3, Paragraph 3

The following statements raise two important issues in this EA:

> Solvents and pesticides observed offpost may derive from offpost sources unrelated to RMA. The spatial pattern of contamination and the plausibility of transport pathways from RMA, as well as a limited review of readily available information characterizing offpost sources, will be considered in evaluating cause/effect relationships between offpost contaminants and RMA.

The first issue is why are solvents and pesticides specified as opposed to any contaminant that has undesirable toxicological end points such as DIMP, VX and its degradation products, etc.? The second issue is this: the frequency use of a particular chemical (including a pesticide) is immaterial due to the fact that some chemicals are quite persistent, and a

occasional, inappropriate application or spill of a very persistent chemical may present a greater risk of imminent harm to human health or the environment than the frequent use of a less persistent chemical. Therefore, the information provided by a county extension agent, especially in an area of several land uses (including offpost waste disposal sites), may not provide the identification of the pesticides applied and determined to be present in the study area.

<u>Response</u>: Solvents and pesticides are specified as possibly attributable to other offpost sources rather than DIMP because there is no reason to believe that detections of DIMP are unrelated to RMA.

Whether a contaminant is attributable to persistent and widespread application or occasional "spills", other sources must be considered when detections do not appear to emanate from the primary source. There is no way to investigate "spills" or inappropriate applications of these contaminants, but persistent use of certain contaminants can be addressed, and it is therefore appropriate to do so to the greatest extent possible.

<u>Comment 58</u>: Page 9-3, Paragraph 1 and Page 9-4, Paragraph 1

The components listed for the exposure assessment are apropriate, but the exposure assessment should also include a determination of the population exposure level, i.e., a calculation of the dose incurred.

<u>Response</u>: We are in agreement with this comment. Population exposure level will be addressed by the EA.

<u>Comment 59</u>: Page 9-4, Paragraph 9.2.1

How will the populations and subpopulations be sampled to determine the background levels of chemicals of concern? How will the sensitivity to identified chemicals be determined for the species listed? How will the risk characterization be performed?

Response: Please reference Final Biota Assessment Technical Plan (ESE, 1988).

Comment 60: Page 9-4, Paragraph 9.4

Is this process going to be discussed with the MOA parties? When? Is the How Clean is Clean Committee going to be involved? How? Shell has serious reservations concerning the process which the Army appears to be suggesting. It is possible to multiply conservative assumptions to the point that we are not dealing with an estimate of the risk, but rather an extremely conservative lower bound approaching 99+ percent.

Response: The concerns raised by this comment are valid and will be addressed in the EA. This is a difficult topic to address in the face of substantial uncertainties, but every effort will be made to avoid excessive conservatism.

Comment 61: Page 9-5

This section states that exposure pathways are to be quantified using methods consistent with the Preliminary Pollutant Limit Value (PPLV) approach to the extent quantification is feasible. This approach to exposure pathway identification is unacceptable for the following reasons:

1) The PPLV methodlogy as currently presented does not have the capability to define exposure pathways. The PPLV methodology provides estimates of acceptable daily doses for human exposure to chemicals via exposure pathways assumed a priori of any exposure assessment activities.
2) The EPA provided approval for the use of the PPLV methodology under the condition that it would be used only at RMA onpost and only for soils. Therefore, the use of the PPLV methodology offpost for groundwater and surface water applications is

inappropriate. Furthermore, the PPLV methodology in its present form has numerous serious deficiencies as noted and incorporated in Shell's comments regarding the Army's proposed onpost EA, March 24, 1987.

Response:

1) The PPLV analysis will not be performed independent of the exposure assessment.
2) It is just as appropriate to apply the PPLV methodology to water as it is to soils. As a matter of fact, the PPLV methodology would result in the same equation as that used to derive Federal Ambient Surface Water Quality Criteria of Federal MCL's if the exposure assumptions were the same as adopted in developing these ARARs. The PPLV methodology is proposed as a method to consider additional exposure pathways as required in Superfund guidance as well as to evaluate site-specific differences in exposure.

Comment 62:
Page 9-5 and 9-6

This section does not provide any discussion of the appropriateness and justification for using chemical specific parameter uncertainty distributions, developed for the onpost EA, in the offpost study area.

Response:

Parameter uncertainty distributions developed onpost will be used offpost where they are applicable. For example, the uncertainty in Koc is generically applicable regardless of location. The parameter uncertainty distribution governing fish consumption rates onpost was developed from a statewide data base which is just as appropriate offpost as onpost.

Comment 63:
Page 9-6,
Top of Page

When will the Army provide the environmental fate studies performed by USAMBRDL for review and comment to the MOA parties?

Response: This information was provided by the Army on October 14, 1987.

Comment 64: Page 9-6, Paragraph 1

How will the onpost data be extrapolated to the offpost EA?

Response: Extrapolation is not planned and that word was not used in the referenced paragraph.

Comment 65: Page 9-6, Paragraph 9.2.6

How will the existing contaminant distribution be reconstructed? It might be more cost effective to discuss this process before the contractor attempts to determine this as it can easily be challenged based on the sparse data and assumption which would have to be made.

Response: The language in the Technical Plan refers to the process of calibrating a ground water contaminant transport model, wherein a model is considered calibrated if it has demonstrated the ability to reproduce the existing contaminant distribution from known source distributions and a calibrated flow model. In this instance, a model is said to be calibrated, and it is reasonable to place confidence in its ability to predict future contaminant distributions. In a quantitative sense, the reliability attributed to predictions can be related to the errors between the observed and the "reconstructed" or "hindcast" simulation of the existing distribution. If computer model simulations are used in the EA, their reliability will be assessed via rigorous statistical evaluation of their skill in reconstructing the existing contaminant distribution.

Comment 66: Page 9-7

The intent of this section is to develop estimates of chronic doses via the development of Single Pathway Pollutant Limit Values (SPPLV) through use of the PPLV methodology. Confusion is created in this section by

the following statement: "Combination [sic] of single pathways appropriate for various land uses will be defined." Confusion is created by the fact that this EA focuses on contaminated ground water and surface water, and the fact that the EPA has provided conditional approval of the PPLV methodology (as described above), it is not readily apparent whether the term "various land uses" is intended to imply various exposure routes such as the inhalation of solvent vapors from industrial activities, etc., or intended to indicate the potential for the population to be exposed to a variety of chronic doses of contaminants through a variety of exposure pathways as defined by the PPLV methodlogy. In suggesting the use of SPPLVs for estimating chronic doses of contaminants, the Army has confused exposure, the value provided by an SPPLV calculation, with dose, the degree to which the chemical contaminant is transferred across the body membrane in contacts (see Draft Superfund Exposure Assesment Manual, EPA, January 1986).

This section also lacks an adequate description of the software developed for the onpost EA, and to be used offpost, for the stochastic uncertainty analysis. This description, when provided, should indicate whether EPA protocols as described in Development of Statistical Distribution or Ranges of Standard Factors Used in Exposure Assessments, EPA, August 1985 are followed.

Response: The quoted section of the Plan should have said "various water uses" rather than "various land uses". It is expected that this correction substantially addresses the issues raised by the comment.

The software represents a statistical uncertainty analysis, similar in its objectives to a Monte Carlo simulation, but based on an alternative procedure known as Latin hypercube sampling. The referenced EPA

publication addresses variations within the population in body weight, surface area, and pulmonary ventilation. The uncertainty analysis proposed for the offpost EA addresses a wider range of behavioral and environmental fate factors that affect estimated exposure to a much greater extent than population variability in the aforementioned factors. Population variation in skin surface area is significantly less than the uncertainty in plant uptake rates from contaminated irrigation water, for example. Information from Development of Statistical Distribution or Ranges of Standard Factors Used in Exposure Assessments, EPA, August 1985 will be utilized as appropriate.

Comment 67:
Page 9-7,
Paragraph 9.2.7

Again, when does the Army intend to discuss Shell's comments offered over 5 months ago on the PPLV process. As originally proposed we do not concur this process is to be utilized without modification. Also, the uncertainty process needs to be discussed with the MOA parties is more depth than has been done to date.

Response:

Responses will be made in the context of Task 35 (onpost EA) and the RMA "How Clean is Clean" Task Group.

Comment 68:
Page 9.7,
Paragraph 9.3

Again when does the Army intend to discuss the comments received on the various proposals for identifying the chemicals of concern? In addition, it is hoped that Shell's comments on recognized sources of toxicological information will be utilized.

Response:

Discussion and incorporation of Shell comments on chemicals of concern and sources of toxicological information will be achieved in the context of Task 35 (onpost EA) and the RMA "How Clean is Clean" Task Group.

Comment 69:
Page 9-7

1) The major objective of a toxicity assessment is the determination of the maximum dose which produces no significant adverse effect in exposed organisms

(Toxicology Handbook EPA, August 1985). Section 9.3 does not describe how the threshold value for each chemical will be determined, and how margins of safety will be applied to the data.

2) The toxicity assessment should consider the ingestion of drinking water as the primary route of exposure. Since the toxicity assessment for the onpost EA considers the ingestion of soils as the primary route of exposure, the toxicological profiles prepared for the onpost EA may not be appropriate for the offpost EA.

3) Furthermore, the toxicity assesment should describe the protocols to be used to correct for toxicokinetic differences.

4) The toxicity assessment should emphasize body dose vs. drinking water contaminant concentrations and not "acceptble dose" vs. ground water contaminant concentrations.

5) Finally, the EPA Guidance for Carcinogen Risk Assessment should be used for the toxicity Assessment and should be followed. Use of the Cancer Assessment Group (CAG) methodology should be avoided because risk assessments based on the linearized multistage procedure reflect conservative upper bounds on risk, not estimates of the risk, and are not a reflection of what the true risk is likely to be.

Response:

1) The toxicity assessment follows the recommendation of the Superfund Public Health Evaluation Manual.

2) Toxicological profiles prepared for the onpost EA will be utilized in the offpost EA only to the extent that they are applicable to the routes of exposure under consideration.

3) The comment on "toxicokinetic differences" is vague. Toxicokinetics will be evaluated consistent with EPA guidance.

4) This comment is also difficult to interpret. It is recognized that an "acceptable dose" is a dose determined to be safe with a reasonable margin of safety, and that minor exceedances of the acceptable dose will not necessarily be harmful. It is also recognized that drinking water concentrations at the tap may differ from ground water concentrations, especially for volatile contaminants. Ingestion of drinking water is not, however, the only use, and may not even be the most important use of groundwater in the offpost area.

5) It is recognized that the EPA values are conservative. However, it is the position of EPA and the Army that the CAG methodology is appropriate for determining carcinogen D_T values. If EPA undertakes a new methodology, D_T values will be revised accordingly.

<u>Comment 70</u>: Page 9-7 through 9-9

This section provides a framework for the performance of a risk characterization, but could be strengthened if the following items are adequately addressed and included in this section:

1) Shell's comments regarding the Army's proposed onpost EA (March 24, 1987) are incorporated, as appropriate, into the offpost EA;

2) A summary of the risks associated with the site including such factors as the weight of evidence associated with each step of the process and the distribution of risk across various sectors of the population;

3) An evaluation of the potential or actual risks to public welfare; and

4) Where quantitative estimates are not possible, a comparison of the data to Applicable or Relevant and Appropriate Requirements (ARARs).

Response:

1) All Shell comments regarding the Army's proposed onpost EA will be incorporated into the offpost EA as appropriate.

2, 3, 4) Each of the last three items outlined in this comment will be addressed in the offpost EA.

SECTION 10.0

Comment 71: Page 10-2

Information of the site background, the nature and the extent of the problem, and previous response activities presented in the remedial investigation could be incorporated by reference. Any changes to the original project scope should be discussed and justified based on the results of the remedial investigation. Following the summary of the current situation, a site-specific statement of the purpose for the response, based on the results of the remedial investigation, should be presented. The statement of purpose should identify the actual or potential exposure pathways that should be addressed by remedial alternatives. The Army does not present any of this information in their proposed FS section.

Response:

The Army agrees that the information specified in Shell's comments should be incorporated in the proposed FS report.

Comment 72: Page 10-2

This section omits the introductory section (as suggested in EPA's "Guidance on Feasibility Studies under CERCLA, June 1985) with three very important subsections: Site background information, nature and extent of problems, and objectives of remedial action.

Response;

The Army agrees with Shell's comment. The following subsections will be incorporated in the FS Introduction Section:

- Site background information;
- Nature and extent of the problem; and
- Objectives of remedial action.

<u>Comment 73</u>:
Page 10-4,
Paragraph 1

It would be helpful if the Colorado regulations which the Army considers as ARARs were listed in this section.

<u>Response</u>:

The ARARs will be developed during Task 39, and it is, therefore, premature to include the ARARs in this Technical Plan.

<u>Comment 74</u>:
Page 10-5

This section fails to describe how and by whom the determination will be made as to which state or federal ARARs are applicable to the establishment of the offpost water quality criteria and the remediation alternatives.

<u>Response</u>:

The determination of which ARARs pertain to the Offpost Operable Unit will be made by the U.S. Government in accordance with the provisions of the RI/FS Process Document.

<u>Comment 75</u>:
Pages 10-6
and 10-7

This section should describe established, site-specific remedial response objectives. The statement, "Alternatives may involve different technologies for different types of waste,....." is not applicable for this FS if the focus of the FS is offpost ground water and surface water.

<u>Response</u>:

The RI will address various contaminated media and could, therefore, require that the FS respond to other media in addition to ground water and surface water.

<u>Comment 76</u>:
Section 10.3.1

The use of diversion as an appropriate response action should not be considered because 1) their "permanence" is not provided by the alternative, and 2) diversion only transfers the contaminants to a different location and/or a different media.

<u>Response</u>:

All types of remedial responses are considered at this stage of the project. Shell's recommendation not to

consider diversion as an appropriate remedial response may be correct, but it is premature at this time. All responses will be evaluated equally during technology screening.

Comment 77: Page 10-9, Paragraph 3

How does in-situ treatment apply to the offpost ground water and surface water?

Technologies cannot be eliminated soley based on commercial availability. SARA provides for evaluating emerging technologies in field applications. Where the evaluation demonstrates that the technology was unsatisfactory, then it would be reasonable to apply another emerging technology, or an alternate proven technology. Hence, Figure 10.3-2 is incorrect in eliminating adequately developed technologies.

This section should state that the remediation technologies will be screened to ensure that they contain the following criteria: protective of human health and the environment, cost effective, and that utilize permanent solutions and alternative treatment technologies or resource recovery technologies to the maximum extent practicable.

Response:

No specific in-situ treatment for offpost ground water or surface water remediation is specified in the Technical Plan. Rather, the reference to in-situ treatment is an example of a technology that may be applicable in the offpost study area.

Figure 10.3-2 is correct in that it refers to the adequacy of development of a certain technology, not its availability.

Technologies will not be eliminated solely based upon commercial availability. The technologies will be screened to ensure that they contain the criteria that are consistent with the CERCLA and SARA.

Comment 78: Page 10-11 through 10-13

This section is presented in an ambiguous form, and the intent of this section is not clearly stated. This section should, at a minimum, establish remedial response objectives, and describe a comprehensive, site-specific approach for the development of remedial technologies, response objectives, and other appropriate considerations in the development of remedial alternatives. This section should also document the rationale for excluding any technologies excluded in the screening of technologies, Section 10.3.2 (above).

Response:

The purpose of the Alternatives Development is to form remedial alternative programs from the technologies which passed the technology screening process. The alternatives will address remediation of specific operable units which could possibly include ground water, surface water, soils, and sediments. Action levels will be defined before the technology screening. The response objectives will be established during to the final selection of alternatives. Rationale for exclusion of technologies will accompany the description of the technology screening process.

Comment 79: Page 10-13, Paragraph 1

The Army has omitted that the NCP specifies the evaluations of "acceptable engineering practices" in the inital screening of alternatives; the NCP does not use the term "implementability".

Response:

"Implementability" is specified in the "Guidance on Feasibility Studies under CERCLA" as well as EPA's "Interim Guidance on Superfund Selection of Remedy" and includes acceptable engineering practices.

Comment 80: Page 10-13, Paragraph 2

A reference citation should be provided for the "interim SARA guidance".

Response:	Interim SARA guidance refers to reference U.S. EPA 1986a as described in the Task 39 Technical Plan Bibliography.
Comment 81: Page 10-14, Paragraph 1	A description of the "implementability" factor should be provided in paragraph 1 of this section. How is the "implementability" to be determined, and what is the minimum acceptable level of effectiveness?
Response:	"Implementability" is "The relative ease of installation and the time required to achieve a given level of response." The question of whether a technology or alternative can physically be implemented in the offpost study area and can provide desired results in a timely manner must be answered in the affirmative to be considered for remediation.
Comment 82: Page 10-14, Paragraph 2	Considerably more detail should be provided on the calculation of the present worth cost for each alternative. Also, the range of accuracy of the present work cost estimates, +/- 150 percent appears to be unacceptably broad; an explanation of the necessity for this range should be provided. As presented, it is unlikely that the alternatives can be reliably screened on the basis of cost.
Response:	Present worth calculations are straightforward computations that will be shown in the FS report. The costs will be based on an accuracy of -30 to +50 percent as specified in EPA's "Guidance on Feasibility Studies Under CERCLA".
Comment 83: Page 10-16, Paragraph 2	The risk level needs to be presented, and the conditions where ARARs do not apply should be discussed. Are ACLs to be considered here?
Response:	Risk levels cannot be presented at this time because the ARARs have not been developed and we do not know which

ARARs will apply. ACLs may be considered if appropriate.

Comment 84: Page 10-17, Paragraph 4	The statement "[L]ong term effectiveness of land disposal" is probably inappropriate for the offpost FS. The present worth analysis will be calculated using a discount factor of 10 percent. But, projects having a high annual operating costs usually look more attractive at high discounts rates. Therefore, the present worth analysis should also be calculated using rates of 4 and 7 percent (EPA suggested values). The cost on each remedial alternative should be presented as a range of costs.
Response:	This question is unclear and appears to apply to other sections.
Comment 85: Page 10-20, Paragraph 3	The percentage of the costs attributable to contingencies should be presented.
Response:	Contingency costs will be specified in the FS report and will be consistent with similar remedial actions and current EPA policies.
Comment 86: Page 10-21, Top of Page	It has appeared that this document was really written for an onpost EA and FS. Since an onsite landfill is mentioned in this section, it demonstrates that this document needs to be reviewed keeping in mind that the principles accepted here will be hard to argue against in the comparable onpost report!
Response:	We concur with the comment. All types of remedial actions are included in the Technical Plan as required by the National Contingency Plan. At the Technology Screening stage, inappropriate technologies will be eliminated and justification will be provided.

Comment 87: Page 10-21 and 10-22	This section as presented is unacceptable. It should present discussion on the evaluation of the alternatives by a detailed development of the following elements of the remedy: 1) Technical analysis; 2) Environmental analysis; 3) Public health analysis (including community relations); 4) Institution analysis (including community relations); 5) Cost analysis; and 6) Evaluation of cost-effective alternatives.
Response:	This section is appropriate and will include the six analysis elements described by Shell.
Comment 88: Page 10-21, Paragraph 3	The "containment only" alternative is probably inappropriate for the offpost FS.
Response:	Containment may apply from the standpoint of subsurface barriers or containment basins for ground water or landfills for contaminated soils/sediments. At this stage of the RI/FS process, it would be premature to eliminate containment from further consideration.
Comment 89: Page 10-22, Paragraph 1	Is the reference to a "Simple consensus among selected individuals" an inference to the "How Clean is Clean" committee? If not, who are the selected individuals and how will they be selected? The intended use of subjective methods for this FS, as indicated by the following statement, should be clarified: "[S]ubjective methods where alternatives are not assigned a specific rating against each criteria are not more widely accepted."

Furthermore, the Army does not convey to the reader in this paragraph how the alternatives are to be analyzed; they allude to what should be done and do not explain what will be done.

The utilization of various unquantifiable or intangible factors can work both ways in any selection process. What has been EPA's track record when private funds are used in the cleanup?

Response: The U.S. Government will select the persons to be involved in the analysis of alternatives. This group will review all of the alternatives, will determine which alternatives meet the minimum requirements as set forth in the NCP, and will rank the alternatives according to their cost effectiveness.

A numerical analysis will not be used to grade, rate, or rank alternatives. Rather, best engineering judgement, along with input from the evaluation team on applicable impact of various alternatives, will be used to select the most appropriate alternative. The specific method for applying subjective factors to the analysis process will be developed during Task 39.

Comment 90: Pages 10-22 through 10-24
This section should indicate that a prelimary report will be prepared and released for comment by all of the MOA parties.

Response: As with other RMA reports, a preliminary report will be prepared and released for review and comment by the OAS.

Comment 91: Page 10-24, Paragraph 2
In the absence of ARARs, upon what criteria and with what procedures will the healthbased [sic] level be established?

Response: The criteria and procedures for developing health based levels will be specified when it is clear which ARARs are available.

RESPONSES TO
ENVIRONMENTAL PROTECTION AGENCY COMMENTS ON THE
TASK 39 DRAFT FINAL TECHNICAL PLAN
MAY 1987

Review Comments

Comment 1: Page 1-6, Paragraph 1, Sentence 5

"Although DIMP may not be a 'hazardous substance, pollutant, or contaminant' as those terms....pathways." The basis for aposition that DIMP is not a contaminant, pollutant, orhazardous substance is not available to EPA or other MOA parties, so it is at least premature to state such a position. A thorough review by all parties will be needed as soon as pending new information becomes available.

Response:

Available data presently indicates that DIMP comes within the definition of "pollutant or contaminant" in CERCLA Section 101(33), 42 U.S.C. Section 9601(33), although not within the meaning of "hazardous substance" as defined in that section. The text will be revised accordingly to reflect that DIMP is a CERCLA "pollutant or contaminant."

Comment 2:

Section 22 is in need of further evaluation considering the varying contaminants found in and upgradient of this section.

Response:

We are in agreement that additional monitoring was needed in the area of the northwest boundary in the alluvial aquifer. To fill this need, an alluvial monitoring well has been installed at Site E-55 which is approximately 2,600 ft from the south line and 1,600 ft from the west line of Section 22. This is approximately 1,800 ft downgradient of the Northwest Boundary Containment System. Also, an additional alluvial

monitoring well has been installed at Site E-67 which is approximately 2,400 ft from the south line and 20 ft from the east line of Section 21. This is approximately 2,900 ft downgradient of the Northwest Boundary Containment System. Both of these wells were installed under Task 25, and data will be integrated into the offpost Remedial Investigation/ Feasibility Study (RI/FS). These wells are both shown in the composite drilling program. Data from these wells will be evaluated, and we will assess the need for additional monitoring in this area.

<u>Comment 3</u>: Figure 2.1-1

Well E-55 is missing in section 22. Well E-55 is not in the list of low priority wells on page 2-5, however it has been drafted on map 86946-01 as a low priority well. The low priority wells from the list on page 2-5 are inconsistent with the symbols on the insert map no. 8646-01.

<u>Response</u>:

A well has been installed at Site E-55 and is shown in the Composite Well Drilling Draft Final Technical Plan. This well was initially considered a low priority well but was upgraded to high priority and installed under Task 25. No specific symbol is being used in Figure 2.1-1 to denote low priority wells. We are unclear as to which map is being referred to when 86946-01 is mentioned.

<u>Comment 4</u>: Figure 1.4-1, 1.4-2, A-1 to A-9

References for the different controls and values assigned to control points would better facilitate the evaluation of the information.

<u>Response</u>;

References for the controls and values assigned to control points in Figures 1.4-1, 1.4-2, and Figures A-1 to A-9 are provided in the Contamination Assessment

Report (ESE, 1987). These figures are included in the Technical Plan only for the purpose of providing a summary of water quality data in the offpost area.

Comment 5: Task 39 is in need of evaluating all potential pathways including ground water, surface water, soils, sediments, air and biota.

Response: Task 39 will evaluate all potential pathways in the offpost area. Since there is little question that ground water is the primary pathway in the offpost area, more emphasis has been placed on it in the RI. However, the other pathways will be examined to determine their significance in the study area.

Surface water samples have been collected on a quarterly basis (currently under Task 44) at the monitoring points shown in Figure 1.4-3. Additionally, points of potential ground water infiltration are being evaluated by examining stream bottom elevations relative to alluvial water levels. Since this appears to be the primary mechanism by which surface water can become contaminated offpost, this assessment will help define the extent of any contamination.

Offpost sediments were examined for all target analytes under the Offpost Contamination Assessment Report (CAR) (ESE, 1987). Additional sediment sampling is being considered for the offpost area. Details of this additional work will be presented in a letter and sent to the Organizations and the State (OAS) prior to the initiation of field activities.

Examination of soils as an exposure pathway will be addressed in the Endangerment Assessment (EA). This

evaluation will focus on scenarios, primarily irrigation and shallow ground water conditions, where contaminated soils can become an exposure pathway. Conservative estimates of soil contamination will be made by evaluating ground water quality and estimating partitioning between the soil and water.

General Comments

Comment 1: References to various criteria, standards and guidelines throughout the text are unclear. These terms have very specific definitions and are related to specific legislation such as the Safe Drinking Water Act and the Clean Water Act. They should not be confused with site-specific action levels or cleanup goals. In addition, it should be noted that when contaminants having the same physiological endpoint occur together in the same media, the MCLs for each contaminant individually may not be protective.

Response: The language in the text will be modified to be consistent with terms used in specific legislation. The levels to which contaminant concentrations are to be treated to in the study will be consistently addressed as cleanup goals to avoid confusion between terms. The additive effects of contaminants will be considered.

Comment 2: The Endangerment Assessment needs revision to provide a clear indication of how site-specific data for this assessment will be collected. In addition, Section 9 could be re-organized to follow the process more closely (see Comments 5 and 10-13 below).

Response: Please see responses to Comments 5 and 10-13 below.

Specific Comments

Comment 1: Page 1-4, Third Paragraph	According to Contamination Assessment Reports (ESE, 1987), this list of contaminants appears to be incomplete. The more recent information should be used.
Response:	The list on page 1-4 is not intended to provide a complete list of RMA contaminants but, rather, a summary of those identified by Spaine et al. (1984). A more complete discussion is provided in the Contamination Assessment Report (ESE, 1987).
Comment 2: Page 1-5, Figure 1.1-1	The Off-Post RI study area should be shown for reference to regional features to supplement Figure 1.3-1.
Response:	The offpost study area will be shown on Figure 1.1-1 in the Final Technical Plan.
Comment 3: Page 1-6, Second Paragraph	References to guidance levels, water quality criteria and standards in this paragraph are confused. Water quality criteria are not "developed as part of the EA process" and cleanup goals are not necessarily "standards." "Water quality guidance levels" should be referenced. "Ground water quality criteria" should be defined. Is the reference to Safe Drinking Water Act (SDWA) standards or Clean Water Act (CWA) criteria? The EA process does not develop criteria or establish standards, it only assesses risk and suggests cleanup goals.
Response:	As stated in our response to General Comment #1, the complete text of the Final Technical Plan will be revised so that consistent references to criteria, are defined and the end product of the EA risk assessment

for specific contaminants are referred to as "cleanup goals".

Comment 4: Page 1-11, Second Paragraph, Third Sentence	According to NOAA records for 1985-80, Denver averages 15.31 inches of precipitation per year, not "76-102 inches per year."
Response:	The average precipitation quoted in the text is incorrect. We agree that approximately 15 inches of precipitation per year is appropriate. The text will be corrected to indicate this change.
Comment 5: Page 1-20, Section 1.3.5	This section is inadequate and Sections 2-8 need to be modified to ensure that adequate information will be collected.

Information needs to include at least the following:

- Site demography (residential population, day-use population);
- Water Use (existing wells, surface water use, potential users planned future use);
- Land Use (acreage utilized for crops, livestock, wildlife, etc.)
- Natural History (critical habitats, threatened or endangered species, wildlife and fisheries information)
- Barr Lake - A significant area of wildlife habitat that should be investigated and discussed separately.

Although this information will be evaluated in the Endangerment Assessment, data acquisition methods should be specified. For example, will there by any field surveys, consultation with Colorado Division of

Wildlife, review of existing reports for data gaps, etc. Clearly, the potential exists for more than a ground water problem yet the focus is almost entirely on ground water.

Response: We are in agreement that the Draft Final Technical Plan focuses primarily on ground water. As discussed in our response to Review Comment #5, surface water monitoring is continuing offpost and sediment monitoring is being initiated. Data relating to the five specific areas mentioned in this comment will be collected during the Remedial Investigation in conjunction with obtaining data required by the EA. These data collection efforts have included field surveys, consultation with the Colorado Division of Wildlife, the Agricultural Extension Service, review of existing reports, etc. These efforts have specifically focused on accumulating adequate data for the EA and identifying data gaps to be filled as the study progresses.

Comment 6: Page 1-33
Variability of contaminant concentrations in Barr Lake should be considered in design of the study plan.

Response: One of the primary considerations of the plan to conduct additional surface water monitoring is the anticipated variability of contaminant concentrations in Barr Lake.

Comment 7: Page 2-2, Figure 2.1-1
No new wells are proposed for Section 22, yet as stated on page 1-22, "the number of data points along the northwest boundary is too sparse to clearly define possible migration". Chloride (p. 1-28), solvents (p. A-1, A-2), chlorinated pesticides (p. A-3, A-4), and DBCP (p. A-47, A-8) were detected along the northwestern boundary. In addition, there is a "known zone of aquifer contamination" (Offpost C.A.R., p. 12-91)

trending northwesterly from the Arsenal through the southern half of Section 22. A review of Task 4 analyte data verified this onpost plume; dieldrin, isodrin, PP-DDT, TRCLE, 11 DCLE, and chloroform were detected in alluvial wells within Sections 22 and 27. Considering the above information, more alluvial wells should be drilled in Section 22 near the northwest boundary to fill in data gaps. Existing well sample data is insufficient to show if, or how far, the northwest-trending contamination zone extends into the offpost area.

Response: Additional wells were installed downgradient of the northwest boundary under Task 25 as described in the response to Review Comment #2 and shown in the Composite Drilling Program Technical Plan. Data from these wells will be integrated into Task 39 and used to evaluate the need for additional wells in this area.

Comment 8: Page 3-3 No mention is made of trip, field, or decontamination blanks to be collected during sampling activities.

Response: The field QA/QC program includes the collection and analysis of volatile trip blanks, rinseate blanks, and field blanks.

The volatile trip blanks involve transporting three filled blank volatile septum vials to the field each week samples are collected for GC analyses, returning the vials to the laboratory, and analyzing the water in the vials.

The rinseate blanks are obtained by decontaminating the bailer used to collect samples, pouring deionized water into the cleaned bailer, transferring the rinse water

into a sample bottle, and analyzing the rinseate. This check is conducted each week samples are submitted to the laboratory.

Field blanks are obtained by pouring organic-free deionized water directly into sample bottles, transporting the sample bottles to the laboratory, and analyzing the water. This evaluation is also conducted each week samples are submitted to the laboratory.

Comment 9:
Page 4-2

Given the occurence of vinyl chloride in ground water south of 80th street and the fact that it is a know metabolite of other chlorinated solvents, it would appear to be a necessary addition to the analyte list. In addition, why have benzene and toluene been removed from the analyte list? Alkalinity and TDS would be useful additions to the inorganic analytes, the former to complete the water analysis and allow for charge balance determinations, and the latter as a check on the total recovered mass of salts in the sample.

Response:

Benzene and toluene were inadvertently omitted from the analyte list in Table 4.0-1. Both analytes have been included in all Task 39 sampling and analysis. The inclusion of vinyl chloride into the offpost monitoring program has been discussed with the OAS and inclusion will be evaluated based upon GC/MS analysis onpost and offpost. Alkalinity has been added to the offpost monitoring under Task 44 and the Comprehensive Monitoring Program. Total dissolved solids (TDS) are also under consideration for inclusion into offpost monitoring programs.

Comment 10:
Page 9-1,

None of the specified RI tasks include collection of data pertinent to air, biota, or soil/sediment pathways.

First Paragraph, Third Sentence

What is the plan for collecting these data? The potential is high in particular for discharge of contaminated ground water to streams that may lead to contamination of sediment and the biota. The potential for soil contamination from irrigation with contaminated ground water should also be addressed.

Response:

Relative to the airborne pathway, onpost air quality data will be utilized along with a source survey in the offpost area to formulate an estimate of the air quality conditions north of RMA. If airborne contaminant sources are identified in the offpost area which could potentially affect the human health and the environment, these sources will be investigated more thoroughly. Investigations may include emission inventories and sampling.

Potential exposure by contaminated soil will be assessed by addressing the two specific scenarios by which this pathway could be significant. Surface soils can become contaminated by irrigation or shallow water table conditions. In both of these cases, the extent of soil contamination can be assessed by evaluating ground water quality in the area of concern and estimating partitioning between the water and soil. This evaluation will be performed conservatively in the EA to ensure that this potential pathway is adequately addressed.

Initial sediment analyses were performed in the offpost Contamination Assessment Report (CAR). In addition, offpost surface water monitoring continues to be performed under Task 44 on a quarterly basis. Potential contamination of sediments can be addressed qualitatively and semiquantitatively by assessing

surface water quality and the mechanisms by which these contaminants can concentrate in the sediments (i.e., adsorption, precipitation, co-precipitation, etc.). Additional sediment sampling and analysis is being conducted by the Army. Details of this program will be presented to the OAS in a letter for review prior to the initiation of field activities.

The assessment of biota as an exposure pathway in the offpost study area is being addressed in conjunction with Task 9, the onpost/offpost Biota Assessment. Relevant data from Task 9 will be incorporated into the offpost RI and EA to assess this exposure pathway.

Copmment 11: Page 9-5, Section 9.2.3

See Superfund Exposure Assessment Manual for guidance on this section.

Response:

The Superfund Exposure Assessment Manual will be referenced in the Exposure Pathway Identification process.

Comment 12: Page 9-5, Section 9.2.4

Existing contaminant distribution combined with analysis of contaminant fate and transport is used to estimate current and potential exposure for media of interest. These sections are not in a logical sequence.

Response:

We are in agreement that exposure pathway identification follows an evaluation of contaminant distribution and contaminant fate and transport. The text of the Technical Plan will be revised to put these sections in a more logical sequence.

Comment 13: Page 9-7,

Toxicological profiles should also document risk reference dose values (RFD), chronic intake values (AIC)

Section 9.3, Fourth Sentence	and cancer potentcy factors (q^f) (See Superfund Public Health Evaluation Manual) as well as separate sections on human health effects and toxicity to wildlife.
Response:	We agree with this comment, and the text of the Technical Plan will be modified accordingly.
Comment 14: Page 9-7, Section 9.4	This section is unclear and incomplete. In a risk characterization, information from the exposure assessment is combined with toxicity information to evaluate potential human health and environmental risks. The following elements should be included in the risk characterization: o General toxicological principles and assumptions used to evaluate risks. o Potential exposures and human health risks under current and future use conditions. o Risks associated with multimedia exposures. o Potential risks to environmental receptors. o Uncertainties in risk assessment.
Response:	The above risk characterization elements will be included in the EA.

ESE

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LETTER OF TRANSMITTAL

To: All Organizations and the State

Project No. 86946-2000-1700

Date: August 19, 1988

Attention: Cpt. Andrew Kengery

Re: Task 39: Final Technical Plan Offpost Remedial Investigation/ Feasibility Study

We are sending you XX Attached ☐ Under separate cover via

Description
Final Technical Plan for Task 39: Offpost Remedial Investigation/
Feasibility Study.

These are transmitted as checked below:

☐ For approval	XX For review and comment	☐ Returned for corrections
☐ For your information	☐ Review and correct	☐ Prints returned after loan to us
☐ As requested	☐ Review and file	☐

Remarks: Enclosed is a copy of the Final Technical Plan for Task 39: Offpost Remedial Investigation/Feasibility Study. The plan has been prepared by Environmental Science and Engineering, Inc. to incorporate comments provided by all of the parties. Individual responses to all comments received are provided in Appendix D of the plan. If there are any questions please contact Mr. Charles Scharmann at (301) 671-3261.

Copy to: Army
D. Todd
J. May
P. Chiaro
M. Rhoades
D.P. Associates
RIC

Signed: B. Stewart